Water Hyacinth in Africa and the Middle East

A Survey of Problems and Solutions

Edited by
Luis Navarro and
George Phiri

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE
Ottawa • Cairo • Dakar • Johannesburg • Montevideo • Nairobi • New Delhi • Singapore

Published by the International Development Research Centre
PO Box 8500, Ottawa, ON, Canada K1G 3H9

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Legal deposit: 4th quarter 2000
National Library of Canada
ISBN 0-88936-933-X

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The catalogue of IDRC Books and this publication may be consulted online at http://www.idrc.ca/booktique.

101-01258/

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PREFACE

Water hyacinth has become a growing problem across Africa and the Middle East (AME). Infestations of this weed are reaching crisis proportions in important freshwater bodies of the region. This is causing environmental, economic, and social problems and accumulated damages that can easily be valued in the order of billions of dollars. It directly affects not only the riparian communities but also all those people who in one way or another depend on environmental services or production from the affected water bodies.

Researchers have been focusing on water hyacinth from various angles of its control and use, and it is apparent that significant knowledge is already available but not used in managing the weed. Early in 1996, responding to requests from across the region for support for research on water hyacinth, the People, Land and Water (PLaW) program of the International Development Research Centre (IDRC) launched an initiative to assess the extent of the water-hyacinth problem across AME and the capacity there to manage it. In particular, the initiative was to explain the apparent lethargy of governments and communities in dealing with impending water-hyacinth infestations in their water bodies. This report summarizes the initiative, its findings, and the recommendations for decision-makers, researchers, and IDRC that emerged from a workshop, Improving Reaction to Water Hyacinth in Affected Countries Across Africa and the Middle East, held in Nairobi, Kenya, in 1997.

Many people participated in making this initiative successful and in preparing this report. It is impossible to make an exhaustive list to acknowledge their contributions, although several are already mentioned throughout this document. We must thank in particular all the people who provided their time and knowledge during our consultations and during the workshop. We also acknowledge the contributions of hard work and expertise from the consultants: Dr George Phiri (team leader) from Malawi, Prof. Yahia H. Fayad and Prof. Ahmed F. Khattab from Egypt, Dr Magzoub Bashir from Sudan, Dr Carina Cilliers from South Africa, and Mr Ousseynou Diop and Mr Mor Dieng from Senegal. Other contributors to this initiative during its conceptual development, implementation, and follow-up included Dr J.B.R. Findlay, South Africa; Dr Hans Herren, International Centre

for Insect Physiology and Ecology; Dr Garry Hill, Centre for Agriculture and Biosciences International; Dr G.W. Howard, International Union for the Conservation of Nature; Dr A.M. Mailu, Kenya Agricultural Research Institute; Dr Dennis McCarthy, United States Agency for International Development–Regional Economic Development Service Office; Dr Faustino Orach-Meza, Lake Victoria Environmental Management Project Secretariat, Uganda; Dr Timothy Twongo, Fisheries Research Institute, Uganda; Dr Paul Woomer, University of Nairobi, Kenya; and Dr Helmuth Zimmermann, Plant Protection Research Institute, South Africa. Finally, we acknowledge the valuable contribution to this initiative and constant encouragement provided colleagues in the IDRC–PLaW team, particularly Dr Eva Rathgeber, Regional Director for Eastern and Southern Africa, Dr Eglal Rached, Dr Ola Smith, and Mr Wardie Leppan.

Luis Navarro
George Phiri

Chapter 1

INTRODUCTION

Water hyacinth (*Eichhornia crassipes*) is an alien, floating water weed that has spread throughout vital freshwater bodies and wetlands of Africa and the Middle East (AME) since the late 1800s. It poses serious socioeconomic and environmental problems for millions of people in riparian communities and is, therefore, an added constraint on development. For instance, more than 12 000 ha of this weed infests Lake Victoria, affecting the livelihood of many of the more than 40 million people in Kenya, Tanzania, and Uganda. The weed obstructs electricity generation, irrigation, navigation, and fishing; increases water loss resulting from evapotranspiration; and facilitates proliferation of such diseases as bilharzia.[1]

Experts agree that sufficient knowledge of the biological, mechanical, and chemical means of controlling water hyacinth exists in AME. Centres within the region also have the expertise to handle the weed problem. However, these centres, together with affected communities, governments, and support organizations, have usually failed to mobilize efforts in time to prevent the weed from spreading to crisis levels. Serious difficulties arise in making the pragmatic decisions needed to mobilize and support people who are able to control the weed, even when financial resources are available. Fortunately, some control efforts — such as those in Benin, Sudan, Zimbabwe, and a few other AME countries — have been successful. They provided useful lessons. However, water-hyacinth infestation keeps getting worse in such major water bodies as Lake Victoria in East Africa, Lake Malawi and the Zambezi River basin in southern Africa, and the Tano lagoon and River Niger in West Africa.

During 1996, the People, Land and Water (PLaW) program of the International Development Research Centre (IDRC) agreed to respond systematically to several requests from across the region to support research on water hyacinth. It launched an initiative to assess the extent of the water-hyacinth problem across AME and the region's capacity to manage it; in particular, the initiative was to

[1] At the time of publication, the infestation had receded significantly and biological control was fairly well established in Lake Victoria. However, this situation is unstable.

explain the apparent lethargy of governments and affected communities in responding to impending water-hyacinth infestations in their water bodies. More specially, the aims of the initiative were

- To identify the main bottlenecks impeding effective control of water hyacinth in AME;
- To increase awareness of the spread and negative socioeconomic impact of water-hyacinth infestations in the region; and
- To stimulate the search for effective mechanisms for water-hyacinth management in AME.

During part of 1996 and 1997, six expert consultants surveyed the literature on water hyacinth and interviewed the key institutions, experts, policymakers, and community dwellers around important water bodies in North Africa and the Middle East, eastern and southern Africa, South Africa, and West Africa. The survey and case-study reports of the consultants, plus notes by other experts, provided the basis for a follow-up consultative workshop of water-hyacinth stakeholders and experts, held in Nairobi, Kenya, in September 1997.

The IDRC–PLaW-led consultations confirmed that water hyacinth is present and spreading in practically all the countries across AME but that the region already has the experience and expertise to deal with the weed on time. The main constraints to the mobilization of available capability are problems of organization and bureaucracy across the various responsible units. Usually, these units act without coordination or communication, often with different or conflicting objectives and limited access to information and resources. Specifically, stakeholders identified the generally poor flow of information and lack of timely access to such information by key decision-makers as the most critical constraints in need of immediate attention. Most critical information relates to the spread and consequences of water hyacinth and to the available knowledge and expertise for early control of water-hyacinth infestations.

Finally, during the September 1997 workshop, stakeholders asked IDRC to start and lead a campaign among governments and donors to develop, install, and support a permanent mechanism for communicating information on water hyacinth. The mechanism was to use modern means of communication and target key experts and decision-makers to facilitate and support timely decision-making and mobilization of efforts to control water-hyacinth infestations.

IDRC complied with the request and, in consultation with governmental institutions and donors, developed the concepts and a "blueprint" for a Water Hyacinth Information Partnership (WHIP). At the time of this publication, the concept of WHIP as a proactive information-communication mechanism had been endorsed by the Lake Victoria Environmental Management Program (LVEMP) and national institutions such as the Kenya Agricultural Research Institute. It has also been incorporated into East Africa Cooperation's strategic regional plan to combat the weed. The financing and installation of WHIP are under discussion among several donors, including IDRC, East Africa Cooperation, and other stakeholders.

This document is a summary report of the findings and recommendations of the survey, case studies, and September 1997 workshop. After this introduction, the document includes sections on the origin and nature, spread and consequences, and the methods for handling the water-hyacinth problem across AME. The first part of the document closes by highlighting what the stakeholders identified as knowledge gaps and opportunities for research and development on water hyacinth, with attention to their specific requests to IDRC. The second part of this document includes, *in extenso*, the proceedings of the September 1997 consultative workshop. These proceedings contain more details on the activities of the team of consultants, their approach and reports, and the participants in the survey and workshop, in addition to the workshop deliberations and conclusions. Appendix 4 contains a list of institutions and people across the region with expertise in or responsibilities for water hyacinth.

PART I
Problems and Solutions

Chapter 2

ORIGIN AND NATURE OF WATER HYACINTH

Water hyacinth (*E. crassipes*) is a flowering, floating, freshwater plant, native to South America. It has beautiful, large, pale-blue flowers, with purple and yellow spots on the petals and shiny, round green leaves. The flower can be bought in local markets, such as in Dakar, Senegal, where it is a source of income for women. Unfortunately, it grows and spreads so quickly in warmer climates that it is now known as the world's worst water weed.

In AME, the earliest reports on the weed were from Egypt in the late 1800s. Today, however, it is present in the freshwater bodies of practically all countries in the region. People have been enticed to carry the weed as an ornament because of its attractive flower. However, more important explanations for the continental spread of the weed include its capacity to quickly multiply when away from its natural enemies in South America.

Once in a freshwater body, water hyacinth often grows as floating plants or mats, as islands of plants floating freely on the water, or mixed with other vegetation on river banks. In nutrient-rich waters, such as in polluted ponds or lakes, it can grow so quickly that the surface covered by the mats doubles every 4–7 days.

A single shoot of the plant may start a huge infestation. Steamers, boats, canoes, or fishing nets can carry plants upstream. Mats of floating plants may become stranded on banks and shorelines when the water level falls. They float again when the water level rises. Floating plants gather together as mats on the leeward side of river islands, on the windward side of peninsulas, inside river bends, or in quiet lake bays. Healthy mats of water hyacinth become a substrate for the secondary growth of papyrus and other similar plants, which makes the mats more solid, heavier, and more difficult to negotiate, even for large boats.

Connectivity among diverse water bodies has further facilitated the spread of water hyacinth in the region. Another explanation has been the inability of communities and governments to respond to weed infestations before they become crises in their water bodies.

Research and some pilot efforts have shown that water hyacinth can be used as raw material for agricultural fertilizer, animal feed, biogas, paper, board, and even construction materials. The plant can also quickly absorb some heavy metals in the water and can be of use in controlling water pollution. Local experience indicates, however, that debris from its vegetation and roots may make clean water unsuitable for drinking or other domestic uses. Furthermore, the technologies available for potential uses of water hyacinth are not yet competitive in the market, and thus they are ineffective as control alternatives today.

The importance of water hyacinth stems from its potential to produce negative consequences for the productive and habitat quality of water bodies and for the communities that depend on them. For example,

- Water-hyacinth infestations clog irrigation canals, diminishing the amount of water they usually deliver, particularly at their tail ends;
- Waterways and even ports, such as Port Bell in Kampala, Uganda, get too clogged for boats to get through;
- Electricity production becomes more expensive because of the effort needed to prevent the clogging of turbines with mats of the weed, such as at Owen Falls, Jinja, Uganda;
- Mats block light from penetrating river water, which induces changes in the flora and fauna underneath, sometimes hindering fish production and resulting in unemployment and diminished incomes and food for riparian communities;
- Local plants and animals lose their habitats; and
- The quality of drinking, cooking, and washing water deteriorates.

From around the world, there are even reports of village people dying from the problems of heavy water-hyacinth infestation. For example, people have died from

- Starvation because they could not reach food sources;
- Bites of venomous snakes hiding in water-hyacinth mats;

- Attacks by crocodiles taking shelter in water-hyacinth mats;
- Diseases carried by mosquitoes (malaria) or snails (bilharzia) that breed in water-hyacinth environments; and
- Fatigue from pushing canoes through clogged waterways.

Manual and mechanical approaches to managing and controlling infestations of water hyacinth include the use of physical barriers. Such approaches are usually the most effective and quick, but they are also expensive and difficult to organize and sustain. Chemical control can also be quick; it has been successful in Florida, United States, for example. But its management demands more skill, and environmental concerns still impede its acceptance. The preferred option is biological control, using the weed's natural enemies imported from South America and tested for their specificity under the conditions of AME. This is environmentally safe; however, it may take time to establish. The ideal would be an integrated water-hyacinth control, one that makes prompt and judicious use of individual control methods while taking into account the specificity of the infestation.

Chapter 3

Spread and Consequences of Water Hyacinth in AME

A sample survey of 29 AME countries indicated that most of these countries have water hyacinth, and 21 of them confirmed that the weed is already a problem within their borders.

Water hyacinth has invaded various countries of West Africa at various times, but most of the invasions have occurred since the early 1980s. An exception is the Republic of the Congo, where the weed was first noted in 1957. In Benin, people first noticed the weed in 1980–81, in the Ouémé River, but it became an outbreak in 1985. Some records indicate the weed has been in this country since 1977. It was first recorded in Ghana and Nigeria in 1984 (around Badagry Creek and Tema, respectively); the Volta River, Burkina Faso, 1991; Mali, in the 1990s; and Niger, 1990–94.

Water hyacinth is not widely present in West Africa. Some countries, such as Gambia, Guinea (Conakry), and Senegal, are, for practical purposes, still without the weed. In some countries, it only appears in the water bodies of certain regions, for example, southern Benin. In these countries, emphasis should be on creating public awareness to arrest the introduction and spread of the problem.

Water hyacinth was initially recorded in Egypt in the late 1880s, but the potential problem for water resources was not noted until 1932. It became a problem in 1975–85. In general, Egypt had no problem with water hyacinth before the construction of the Aswan High Dam. Until then, the annual flood of the Nile had flushed the weed out to the Mediterranean.

In South Africa, observers first noted the weed in 1910, but not until 1983 did the *Conservation of Agriculture Act* declare it a noxious weed that "must be controlled." This Act is administered by the Department of Water Affairs.

Outside South Africa, water hyacinth has been present in eastern and southern Africa for the more than four decades since it was initially recorded in Zimbabwe in 1937. It continued to colonize important water bodies in the region, such as the Incomati River (Mozambique) in 1946, the Zambezi River and some

important rivers in Ethiopia in 1956, rivers in Rwanda and Burundi in the late 1950s, the rivers Pangani (Tanzania) and Kafue (Zambia) in the 1960s, the Shire River (Malawi) in 1968, and Lake Naivasha (Kenya) in 1982–83. Most recent records of infestations are from lakes Kyoga in Uganda in 1988–89, Victoria in 1989–90, Malawi–Nyasa in 1996, and Tanganyika in 1997.

The IDRC–PLaW consultation found that water-hyacinth infestations are rapidly increasing in AME. Furthermore, many of its consequences and related problems have become known only since the weed has been present in the region. However, these consequences have neither been systematically studied (quantified and documented) nor totally understood.

Examples of the consequences of water-hyacinth infestations are most striking in crisis situations, such as the one in Lake Victoria. The consultant reports indicate that these infestations have had negative impacts on fisheries and fish-related commercial activities; the efficiency of irrigation canals, navigation, and water transport; hydroelectricity generation; and water-storage capacity (for example, as a result of increased evapotranspiration in reservoirs). These infestations can also interfere with communities' access to good-quality water (water pumping and treatment); increase the incidence of such diseases as bilharzia, malaria, and cholera; and induce changes in the aquatic environment, as happens under water-hyacinth mats, where the reduction in dissolved oxygen affects other organisms in the water.

During the consultation, dwellers of riparian communities also pointed to many social, health, and economic problems resulting from water-hyacinth infestations. These include emigration of fishers to other water bodies, difficulties in accessing river banks, protein deficiency resulting from the unavailability of fish, and obstruction of boat and "fish landing sites" (sites where fishing boats land and unload fish).

Although the range of problems with water-hyacinth infestation is in general terms widely known and expected, the real impact on the socioeconomic status and welfare of the people who depend on the affected water has been neither well analyzed nor well documented. This is one of the most certain explanations for why the water-hyacinth problem is still poorly understood. The consultants were unable to obtain solid information on the socioeconomic and welfare effects of water-hyacinth infestations, even on the basis of case studies, but found that this is one of the types of information decision-makers need the most. This is certainly an important knowledge gap and a further challenge for researchers.

Chapter 4

HANDLING THE WATER-HYACINTH PROBLEM

AME has enough experience, expertise, knowledge, and support to effectively control or manage water hyacinth. This is clearly indicated in the consultant reports, which include long lists of organizations, institutions, and government agencies with responsibilities related to the control or management of the weed. These lists, summarized in Appendix 4, include national, regional, and international centres with expertise on water-hyacinth control and management. International organizations that have provided technical support include the International Institute for Tropical Agriculture (IITA), the Commonwealth Scientific and Industrial Organization (Australia) (CSIRO), and the Centre for Agriculture and Biosciences International (CABI). The lists also include agencies that have supported initiatives on water hyacinth, such as the Food and Agriculture Organization of the United Nations (FAO) and the United Kingdom Commonwealth Science Council (CSC), and donors not included in Appendix 4, such as the Gessellschaft für Technische Zusammenarbeit (GTZ) (technical-cooperation agency), the Japan International Cooperation Agency, the Danish International Development Agency, the United States Agency for International Development (USAID), the European Union, and the United Kingdom Department for International Development (DFiD).

In another report, the consultants put together a bibliography with more than 1 000 entries on water hyacinth in AME. This bibliography is available at the IDRC–PLaW website (www.idrc.ca/plaw).

However, the ongoing and accelerating spread of weed infestation indicates that the region has been unable to put its capability to work. The consultation confirmed that the region has serious difficulties effectively mobilizing its capability in response to early signs of risk for water-hyacinth infestation in water bodies across AME. In most cases, an infestation has reached crises proportions before control effectively begins. For example, informants in all of the 21 survey countries where water hyacinth was already a problem indicated that control efforts did

not start until infestations reached crisis proportions. The reasons for the difficulties that national, regional, and even international support organizations have in responding to water-hyacinth infestations are institutional, technical, and financial.

The main institutional constraints have to do with problems of organization and bureaucracy across the many units within a country — sometimes even within one ministry — that deal with the weed. Usually, these units act without coordination or communication, often with different or conflicting objectives and with limited access to information and resources. Specifically, stakeholders identified the generally poor flow of information and the associated lack of timely access to such information by key decision-makers as the most critical constraints in need of immediate attention. Key constraints of this nature concern information on the spread and consequences of water hyacinth and on the available knowledge and expertise needed for early control. Such information should include data on the socioeconomic impacts of water hyacinth and the basic facts about the weed that make it a problem and determine control options.

The unnecessary bureaucracy of responsible institutions slows the initiation and implementation of programs for water-hyacinth control and prevents the effective participation of riparian communities in campaigns to control water hyacinth. Furthermore, most countries have no policy on water hyacinth. Such a policy would designate the weed as a menace to water resources and spell out the need for urgent and effective control and management strategies.

Technical problems include the lack of an appropriate integrated strategy for water-hyacinth control in AME. For this reason, countries in the region use the available control options merely as a series of tools to combat the weed, and their efforts have often been uncoordinated and largely ineffective. When combined with the institutional limitations, technical problems also include

- Difficulties in identification of lead organizations with relevant structures to effectively coordinate control efforts and ensure the full participation of key stakeholders;

- Lack of regional efforts to ensure the collaboration and interaction of key players and the harmonization of efforts to control water hyacinth on a whole-catchment basis; and

- Lack of back-up services for techniques such as mechanical control.

Financial problems emanate from the very belief that efforts to control and manage water hyacinth are poorly funded. This undermines efforts, even when governments and other agencies avail funds.

The consultation also found some instances of success in handling water hyacinth across AME. These experiences offer lessons and should be used to provide models for future action (Chapter 9 gives a summary of these findings). Successful efforts to control water hyacinth were reported from Benin, Egypt, South Africa, Sudan, and Zimbabwe, among others. Mechanical and chemical (herbicide) approaches to water-hyacinth control are the most widely used, for example, in Egypt and South Africa. However, some cases also show the successful use of biological control, for example, in Benin, southern Africa, West Africa, Zimbabwe and, recently, Lake Victoria (East Africa).

Chapter 5

KNOWLEDGE GAPS IN WATER-HYACINTH CONTROL

Information accessibility and flow

In the consultations, stakeholders evaluated the mechanisms used to exchange water-hyacinth information and the existing barriers to effective communication. They also reviewed the key players' access to up-to-date sources of information and modern, quicker, and more cost-effective means of communication, such as the modern information and communication technologies.

Participants acknowledged that centres in AME and beyond had a wealth of water-hyacinth information. However, this information is not easily accessible to key decision-makers, policymakers, researchers, and representatives of communities who might need it in mobilizing and executing effective control, as well as in evaluation programs. Thus, problems occur in accessing information such as the following:

- The actual water-hyacinth problem and the types and magnitude of its socioeconomic and environmental costs;
- The available alternatives for control of water hyacinth and their effectiveness, cost, and possible benefits; and
- Experiences in effective management of the weed problem in other situations within the region and globally.

As a recommendation for immediate implementation, the participants in the survey and workshop asked IDRC to assist in improving the flow of water-hyacinth information in both print and electronic forms. To achieve this, it was

recommended that IDRC champion the setting up and installation of a Water Hyacinth Information Clearinghouse. This mechanism would make information more accessible to key players and facilitate their interaction.

Research priorities

Biological, herbicidal, and physical methods of controlling water hyacinth have been used in various combinations across AME. These efforts have been successful in a few cases but in general have not contributed to the effective handling of the weed. Although a lot of research has been conducted on water-hyacinth control globally, the survey respondents and participants at the workshop acknowledged significant knowledge gaps, including a lack of precise knowledge of the relative effectiveness of various approaches in various situations. Where these approaches have been in use, each one has demonstrated strengths as well as weaknesses. Although everyone agrees on the need to combine more than one approach in an integrated strategy, no one has carried out research on how to develop this for transfer to potential users.

Among the stakeholders consulted, there is a widespread appreciation of the type and seriousness of the disruptions to the habitat and productive functioning of water bodies caused by water-hyacinth infestations. However, it was acknowledged that the exact magnitude of social, economic, and environmental consequences was poorly understood in AME and globally.

These aspects require urgent attention. Research is needed to quantitatively define the impacts of water-hyacinth infestations and to prompt action.

Recommendations to IDRC

Stakeholders also made specific recommendations to IDRC, identifying a niche for IDRC to continue supporting research for development activities focusing on water-hyacinth control and management in AME.

Stakeholders recommended the following:

- Champion and support the installation of a mechanism for information flow and exchange (a Water Hyacinth Information Clearinghouse);

- Support the establishment of a modern electronic-communication infrastructure for strategic centres of expertise on water-hyacinth control and management;

- Support the interaction of key players in water-hyacinth control and management from within AME;

- Support strategic research and studies, such as the quantification of the socioeconomic impacts of water hyacinth on riparian communities; and

- Champion and support the development of early-warning mechanisms for impending water-hyacinth problems.

In response to these suggestions, IDRC, in collaboration with several partners, developed a "blueprint" for a Water Hyacinth Information Partnership (WHIP). The concept and model of WHIP have been endorsed by East African national and regional institutions and is part of East Africa Cooperation's plans for managing water-invasive weeds regionally. Negotiations are under way for WHIP's funding and installation.

PART II
Proceedings of the Workshop

PREFACE TO PART II

Water hyacinth continues to infest freshwater bodies across AME because the region is unable to mobilize existing expertise and resources to control the weed in time. This was confirmed in the 1996–97 survey and consultation initiative of IDRC's PLaW program. The survey culminated in a workshop, Improving Reaction to Water Hyacinth in Affected Countries Across Africa and the Middle East, which was held in Nairobi, Kenya, from 17 to 19 September 1997.

The 60 participants, including experts from the entire AME, were drawn from such fields as biological, mechanical, and herbicidal control of water hyacinth. Also in attendance were academicians, donor representatives, other decision-makers, and representatives of communities — key stakeholders in the region's water resources. These proceedings are the output of the workshop.

The report begins with the welcoming and guiding presentations and the keynote address by Dr F. Orach-Meza, Head of the Ugandan National Secretariat for the Lake Victoria Environmental Management Program (LVEMP). The central two sections focus on the main issues emerging from the regional survey and case studies regarding the status of water hyacinth and its management in the region; and on the recommendations emerging from the workshop for immediate and longer term action to manage the weed. The discussions and the exchange are partly reported here. The report closes with reflections by the organizers and remarks by the IDRC Regional Director indicating IDRC's willingness to follow up on the key recommendations from the workshop. The appendixes include a description of the survey instrument, reports from the three working groups, and a list of participants and their addresses.

One of the key recommendations is to install and support the operations of a Water Hyacinth Information Clearinghouse. This would facilitate the flow of information critical to prompt decision-making by key players responsible for, and capable of, handling the weed problem in AME. IDRC was encouraged to champion this drive among users and supporters.

Luis Navarro
George Phiri

Chapter 6

WELCOMING ADDRESS

Eva M. Rathgeber

Introduction

It gives me great pleasure to welcome you to this very special workshop on improving responses to water hyacinth in affected countries across AME. It is certainly encouraging to see interaction among key policymakers, researchers, various organizations, and community representatives jointly trying to address this very important concern.

Water hyacinth is fast covering useful inland water bodies, changing their environment, and affecting millions of people who depend on them across AME, water bodies such as the Nile, Zambezi, Congo, and Niger rivers, as well as lakes Victoria and Malawi. This has led to a variety of socioeconomic problems among communities and organizations that depend on the affected water bodies, threatening not only food security but also marine transportation and the health of local communities (Njiwa 1996).

For instance, the weed has clogged the Kafue River, which is regarded as one of the most important rivers in Zambia, supporting 40% of the country's 8 million people (Kamyomeka 1997). In Malawi, it is found throughout the Shire River system, including the country's major hydroelectric installations near the intake point that supplies the country's main commercial city of Blantyre (Phiri 1997).

Lake Victoria — a substantial economic resource for a third of the total population of Kenya, Tanzania, and Uganda — has not been spared by the rapid invasion of the weed. Fishing, which generates $320 million a year in fish exports, is adversely affected; waterborne diseases are fast on the increase; and water hyacinth has gradually blocked the navigation channels of the lake basin (Njiwa 1996). The problems of one Kenyan village, Kaduong, south of Kisumu, attests to these facts. The weed has swamped the entire world of this 2 000-strong fishing

community, leaving 52 fishing boats marooned; the godowns where they sold their fish are permanently locked; and the old shorefront hotel has collapsed. Diseases such as dysentery, malaria, and bilharzia have increased (Githongo and Johnstone 1997).

After years of research, technological expertise to control water hyacinth is available. Control efforts have been variously employed but almost always after the spread of the weed has reached a crisis level, as in the case of Lake Victoria. Regional efforts to tame the weed on Lake Victoria, the second largest freshwater body in the world, were initiated when the weed had already covered more than 10 000 ha of lake water in Kenya, Tanzania, and Uganda. Action was taken, in other words, when the situation was already a disaster. Why is action to fight water hyacinth not effected promptly, despite knowledge, experience, and expertise in the region and beyond that could enable communities to combat and manage the menacing weed?

This is a major concern of IDRC, and since 1996, through its PLaW program, it has supported the Water Hyacinth Management Capability in Africa and the Middle East initiative, which seeks to identify ways for national, regional, and international organizations in AME to more quickly establish effective mechanisms to control water hyacinth.

IDRC's program priorities

IDRC is dedicated to supporting research and has actively supported thousands of research projects in Africa, Asia, Latin America and the Caribbean, and the Middle East during the past 27 years. The presence of IDRC's four regional offices in Africa is indicative of the strong emphasis it places on programing in AME.

IDRC's program support is currently organized under six strategic development themes: food security, equity in natural-resources use, biodiversity conservation, sustainable employment, strategies and policies for healthy societies, and information and communication.

Under the theme of equity in natural-resources use, IDRC has funded research on

- Decision-making processes that integrate environmental, social, and economic objectives for shared and common-property resources;

- Resource-management policies for selected regions or countries that face a policy vacuum as a result of recent political disruption, such as in Cambodia and Mozambique; and

- Ways to manage the multiple and often conflicting demands for water in AME.[1]

IDRC is committed to supporting and coordinating critical research to improve the capability of countries in the region to effectively deal with the water-hyacinth problem.

Challenges

The challenges ahead involve not only addressing the current crisis but also developing long-term strategies for effective water-hyacinth control. I cannot overemphasize the urgency in this matter.

As we go through the workshop deliberations, it is my hope that we will identify effective mechanisms to improve the flow of information and the interaction of key players in water-hyacinth management. We should also focus our attention on identifying priorities for research and interventions that will stimulate and support the development of effective control mechanisms.

Let this be a first step in building partnerships, and let us continue to network in this critical area to make a significant contribution to the quality of life of riparian communities in AME.

I wish you a most successful workshop.

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[1] Since the workshop IDRC has changed its program structure but continues to support research on the issues mentioned here as part of its new programing.

Chapter 7

INTRODUCTION AND OBJECTIVES

Luis Navarro

Background

This workshop is the final activity of the Water Hyacinth Management Capability in Africa and the Middle East initiative, an in-house IDRC project implemented as part of the PLaW program. Program initiatives are the discrete units through which IDRC supports research for development today (IDRC 1997).

Why the initiative and this workshop?

What we have learned (and expect to validate at this workshop) is that

- Water hyacinth is not a recent phenomenon in AME;
- AME has plenty of water-hyacinth experience, knowledge, and expertise; and
- There is plenty of water-hyacinth experience, knowledge, and expertise outside AME, including groups with differing approaches to the water-hyacinth problem.

It must be stressed, however, that in practically all cases, water-hyacinth invasion within AME becomes a crisis before measures to control it are begun.

We have become interested in why this is so. However, we are more interested in what can be done now to facilitate the mobilization of available and accessible capabilities and resources to face water hyacinth in a more timely, effective, and efficient manner.

We have also learned that shortage of resources is not a good enough explanation for why the water-hyacinth problem has not been adequately dealt

with. We decided, therefore, to look for more answers in AME, with the following caveat: We are not just looking for a postmortem-type description of the situation. We are even less interested in efforts to identify responsible parties who have not done their work at all or well enough. Nor are we looking for project proposals at this stage. We want to identify ideas that, for starters, will help us to mobilize ourselves here at this workshop, along with others we are interacting with, in efforts to improve our ability to tackle water hyacinth before it becomes a menace. We also want to exploit the beneficial features of water hyacinth, which we all know it has.

We want to carry this interest through this workshop.

IDRC interest

Since our preliminary analyses we have noticed that the availability and timely flow of information are problem areas requiring attention. Because the generation and dissemination of knowledge-carrying information are part of IDRC's business and expertise, we want to give this special attention. We will stay alert to your suggestions.

What has been done?

We have mobilized the attention of the PLaW team and some of our best collaborators: Dr Herren of the International Centre for Insect Physiology and Ecology (ICIPE), Dr Hill of the International Institute of Biological Control (IIBC) (and now of CABI Bioscience), and Dr Twongo of the Fisheries Research Institute in Uganda, among others. Although most of our informal interaction has been with researchers, we have also talked with journalists, fishers, and representatives of the private sector. The message from the private sector is always the same: We are ready and only waiting for the opportunity and conditions for our participation.

As part of our initiative, we engaged a team of seven regional consultants with experience in the subject and an interest in the questions raised. They surveyed the extent of the problem, studied the locally generated literature, looked at the water-hyacinth expertise across AME, and familiarized themselves with the diverse experiences with the weed. Finally, they conducted a few specific case studies, with attention to the socioeconomic and environmental consequences of water hyacinth. We did not ask for detailed or profound technical answers on the development of the weed or its control. We were more interested in the people's experiences in mobilizing, organizing, and equipping themselves for the task and in the effectiveness of their interventions. We will hear reports from five of these consultants, as input and stimuli to your own contributions.

The consultants are Prof. A.F. Khattab, Prof. Y.H. Fayad, and Dr M.O. Bashir, who surveyed mainly Egypt and Sudan; Mr O. Diop and Mr M. Dieng, who worked in a number of countries in West Africa; Dr C. Cilliers, who worked in Namibia and South Africa; and Dr G. Phiri, who was the team leader and worked in East and southern Africa (except Namibia and South Africa).

To conclude the initiative, we staged this workshop, which is expected to validate and enrich our findings thus far.

The workshop

Objectives

The objectives of the workshop are the following:

- *To identify research and implementation strategies to improve the management of water-hyacinth problems in the region* — Priority areas include community participation and organization in handling the weed problem; supporting policies and services from the public and private sectors; and development of technical strategies and tools to control or manage the water-hyacinth problem.

- *To examine the possibility of establishing a Water Hyacinth Information Clearinghouse to facilitate the timely flow of information for related decision-making in the region* — Is this be a useful first step in improving interaction and effective decision-making among key players? If it is, what would be the mandate functions and main activities of such a clearinghouse? How would it be established and sustained?

Process

Our work will be structured in plenary and working-group discussions.

Start-up plenaries

To provide input and guidance for discussions at the workshop, we will start with a keynote address by Dr F.L. Orach-Meza, who is Head of the Ugandan National Secretariat for LVEMP. The consultants will then make brief reports on their findings and case studies.

This will be followed by a plenary discussion in which we expect to get the benefit of your experience, knowledge, and interest.

Group work and discussion of reports

The workshop will then be divided into three working groups, each with the similar task of providing a report with recommendations for immediate and longer term action in response to the objectives of the workshop. The reports from the working groups will be discussed in another plenary, after which each group will go back to incorporate the feedback from the plenary into its own report.

Consolidation and plenary discussion of the workshop report

With the help of the working-group chairpersons, the consultants will consolidate the three working-group reports into one report. This consolidated report will be discussed in a final plenary.

Facilitation

To help us through this workshop, we will have the participation of Ms Amina Kasinga from Eureka Educational and Training Consultants, in Mombasa, who has experience facilitating meetings with audiences like this, where diverse talents and experiences have been brought together. However, this will not be a "fully facilitated meeting" in the modern sense. We will have no warming-up or ice-breaking sessions. More so, we will still use chairpersons for some of the sessions and working groups. However, Ms Kasinga will be there as a resource person to help guide plenary discussions, ensuring that we stick to the objectives and schedule. Each session will also have a rapporteur. People asking questions will be asked to write down the questions in brief for purposes of report compilation.

A secretariat is available to help with arrangements for travel, photocopying, and preparation of transparencies and documentation. Ms Florence Waiyaki will be there to assist you. Dr George Phiri and Dr Luis Navarro will also be available to help.

Once again, I welcome you all and hope your discussions will be enjoyable and productive.

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Chapter 8

KEYNOTE ADDRESS

CHALLENGES FOR IMPROVING REACTION TO WATER HYACINTH IN AME

Faustino L. Orach-Meza

Summary

This keynote address attempts to provide a succinct overview of water hyacinth, its problems, and its control in AME. It assesses, in general terms, the present status of and trends in the water-hyacinth problem, its distribution, and its potential consequences. It also reviews how the problem has been handled across affected countries in Africa and further identifies the main shortcomings and the reasons for these shortcomings.

This discussion raises challenges and potential opportunities for participants to consider in providing recommendations to improve capabilities in Africa for responding to, and effectively handling, the water-hyacinth problem.

Finally, this address anticipates a response from participants on a proposal to establish mechanisms to improve the interaction of key players in water-hyacinth control across the region. It suggests setting up an information clearing-house to facilitate exchange of information and cooperation to more effectively handle the water-hyacinth problem in AME.

Introduction

Many of us recall the many workshops, seminars, conferences, meetings, and consultations that have taken place in various countries to scientifically analyze water hyacinth, identify solutions to the multiple problems it causes, and recommend measures to bring it under control. We have held meetings on water hyacinth since the weed started spreading from its native land in South America to parts of the globe where it has no natural enemies. In the new countries, it has proliferated and

created innumerable problems for communities and the environment. Since these gatherings took place, several action plans for the control of water hyacinth have been implemented in various countries but usually half-heartedly or too slowly, given the prevalence of the weed; and they have had varying degrees of success and failure. An updated review of these interventions will be covered in other presentations. We can, however, ask ourselves why actions to combat the weed have usually not been initiated in time, and why these efforts do not appear to have effectively controlled the weed. What has gone wrong?

The most recent of these many workshops and expert consultations took place in Harare, Zimbabwe; Florida, United States; Kampala, Uganda; and Washington, DC, United States (at the World Bank). These meetings drew wide participation from many countries with an interest in the weed. Water hyacinth continues to feature as a special topic at a wide variety of other related conferences and meetings.

This time around, with a wealth of scientific, technological, and managerial experience and knowledge, a well-thought-out title has been provided for this consultative workshop — with which I am very happy to be associated. The title, Improving Reaction to Water Hyacinth in Affected Countries Across Africa and the Middle East, befits this stage of development in the national, regional, and international efforts to bring this widely recognized menace of our waterways under effective and permanent control, acknowledging that total eradication is impossible. Accordingly, I have headed my keynote address "Challenges for improving reaction to water hyacinth in AME," with a view to asking for a strategic action plan for gearing up effective efforts to decisively win the declared war on water hyacinth.

I presume that everyone at this gathering is concerned about the alarming problems caused by water hyacinth in the aquatic environment of AME. I am therefore urging you to focus on accepting the fact that efforts to combat the weed in most countries of our region have not been prompt, despite the availability of options for control of the weed. This focus should, therefore, aim particularly at improving the capability of riparian communities, their respective authorities, and support organizations to more decisively respond to, and effectively handle, the rapid growth and spread of water hyacinth in our region. Perhaps one missing element in the control of the weed has been adequate communication to facilitate the interaction and practical action of researchers, decision-makers, support organizations, and representatives of other stakeholder groups, including communities. Let us, therefore, make this consultative workshop a forum for reviewing the prevailing inadequacies and for declaring a final assault on water hyacinth. Let us go

from here prepared, as a region, to achieve the effective management of water hyacinth, instead of allowing the water hyacinth to manage us, as seems to be the case today. Only in this way will the future of our aquatic environment be tamed by us, not by water hyacinth, on a sustainable basis.

The nature of water hyacinth

Preparedness to deal with water hyacinth involves collecting information and data on the weed and identifying weaknesses in current control approaches. It also involves an improvement in strategies for effective, prompt, and cost-effective control. Researchers have come up with new findings on the ecological and biological status of water hyacinth (its position in the food chain), on available tools for its control, and on the relative effectiveness of each option.

Gopal (1987) reviewed the literature on the systematic, morphological, developmental, biological, and ecological aspects of water hyacinth. The weed is known to

- Be a successful invader of freshwater, nutrient-rich, eutrophic environments;
- Have a high rate of vegetative growth and multiplication;
- Produce seeds that remain viable for very long periods;
- Have a fairly wide ecological amplitude; and
- Exhibit great phenotypic plasticity.

Ever since its introduction outside South America in places where it has no natural enemies, water hyacinth has created innumerable problems for communities. It interferes with water use by directly obstructing navigation, blocking water-intake points, causing turbidity in shallow waters used for domestic purposes, and interfering with water flow in irrigation channels. It has also been responsible for drastic changes in the plant and animal communities of freshwater environments. It is associated with fish kills and the proliferation of agents of several deadly diseases (Thompson 1991; Willoughby et al. 1993; Orach-Meza 1996).

Exactly when the weed invaded or was introduced into Africa is uncertain, but it began to proliferate in Egypt during the later years of the 19th century. It

then appeared in South Africa, Republic of the Congo, Sudan, Tanzania, Kenya, Zimbabwe, Zambia, and Rwanda. It must have started proliferating on Lake Kyoga in Uganda before 1987, when researchers sighted the weed on the lake (Twongo 1988).

Water hyacinth often grows as mats of floating plants, as islands of plants floating freely on the water, or dispersed among the vegetation on riverbanks. A single shoot of the plant is enough to start a huge infestation. Steamers, boats, canoes, or fishing nets may carry it upstream. The plants multiply and increase rapidly, forming islands of floating plants that may become stranded on banks and shorelines when the water level falls. They float again when the water level rises. Floating islands gather together as mats on the leeward side of river islands, in river bends, in areas on the windward side of peninsulas, or in quiet lake bays. Large mats can penetrate and obstruct narrow channels leading to fish landing sites (where fishing boats unload their cargo). They are also found in clumps of fringing macrophytes, often 10 or 15 m wide. At times, they completely obstruct inlets and fish landings, and they often completely block ferry crossings.

Gopal (1987) indicated that where the plant produces seeds, the seeds may cause a new outbreak of water hyacinth even after a site is completely cleared of an initial infestation. Evans (1963) reported seed production in Zaire. It is also known that birds and animals that feed in sites of water-hyacinth infestation transport the seeds over considerable distances on their feet. Transported seed may have caused most of the current invasion of Lake Victoria. Water hyacinth also multiplies through the production of daughter plants.

The impact of water-hyacinth invasion

Water bodies in Africa are important for fisheries, domestic and industrial water supplies, livestock and irrigation, transportation, communication, sports, recreation, and tourism. They are also important in moderating the climate, as well as sustaining the gene pools of an assemblage of plants, fish, insects, reptiles, and birds. In African rivers, lakes, swamps, and lagoons, water hyacinth has been increasing at an alarming rate. The interdependence of the networks of African waters in neighbouring states has facilitated its spread to new aquatic environments.

Water hyacinth has severe socioeconomic effects on human populations in areas where people depend on lakes and rivers for transportation, fishing, drinking, and meeting other needs. The weed increases the rate of water loss and interferes with agricultural and hydroelectric-power schemes. It also poses serious environmental problems in key wetlands in Africa. In addition, it prevents oxygenation

of water and the establishment of phytoplankton and much of the zooplankton, making areas unsuitable for fish-feeding and fish-breeding. The dense mats of the weed block rural communities' access to areas of water and prevent their setting and removal of fishing gear, which makes fishing impossible.

Obstruction of light by the mats impedes photosynthetic processes, thereby breaking down life cycles and food-web systems in the water. Biodiversity is reduced. The sedimentation, decomposition, and fermentation of dead organisms and rotten weeds may reduce the quality of water bodies (eutrophication). The weed's massive cover also increases the rate of evapotranspiration, resulting in water loss; provides habitat for vectors of malaria and bilharzia; harbours poisonous snakes; causes skin rashes; and can host agents of amoebic dysentery and typhoid. It is also known to have had negative effects on the health of riparian communities and other users of infested water bodies. Debris from its vegetation and roots creates murky water, making it unsuitable for drinking or other domestic uses. These impacts pose an additional burden on the limited health services and facilities available to poor rural communities.

These local experiences of the water hyacinth's negative effects on domestic water supply go against the common knowledge that the weed can purify polluted water. The fact is that water hyacinth can have negative effects on clean water but can also be useful in purifying water heavily polluted with some heavy metals. This feature adds complexity to its management.

The often ineffective and delayed efforts to control water hyacinth have more clearly compromised the health of Africa's water bodies. This weed grows extraordinarily rapidly, so action taken now will limit damage and slow the spread of the weed to new areas in AME.

Available measures for water-hyacinth control

In view of the potentially serious socioeconomic and environmental consequences of water-hyacinth infestation, this workshop should emphasize the urgent need for immediate action to improve the effectiveness of efforts to combat the weed. This is important, as the cost of doing nothing or of not doing anything promptly would be enormous economic losses and environmental degradation in AME.

Over the years, some countries in the region have taken manual, biological, mechanical, and chemical measures to try to control water hyacinth. These have often been accompanied by surveillance and public-awareness campaigns and have achieved some success. In most cases, the methods adopted were derived from recommendations made at conferences, workshops, or consultations with experts.

The 1991 workshop on the Control of Africa's Floating Water Weeds (CSC 1991), held in Harare, Zimbabwe, resulted in the following recommendations for aquatic-weed control at national and regional levels:

1. *On action to control floating water weeds*

   - Favour site-specific controls that integrate biological, physical, chemical, and other methods;
   - Implement biological-control measures as soon as an infestation is confirmed, because this method is the most cost-effective, permanent, and environmentally friendly;
   - Consider appropriate chemical, physical, or other methods when stopgap control is urgently required;
   - Ensure, where other methods of control are needed, that these do not jeopardize biological control; and
   - Prevent, at all costs (especially through legislative measures), the spread of the weed to noninfested regions.

2. *On the role of catchment management in water-weed control* — Given that water weeds can spread rapidly within and between catchments and that the flow of nutrients into water bodies is known to increase the growth of water weeds and make control more difficult,

   - Include control measures as part of a larger land-use management policy for sustainable development of watersheds;
   - Take action to reduce nutrient levels in infested water bodies, where appropriate; and
   - Enforce legislation to control pollutants from point sources.

3. *On research*

- Conduct ecological studies of aquatic ecosystems affected or threatened by water hyacinth;
- Undertake comparative studies of the socioeconomic conditions of communities in weed-infested and noninfested areas;
- Investigate safer herbicides;
- Conduct postrelease studies on bioagents; and
- Study the development of computerized management systems to assist in decision-making.

4. *On training*

Provide PhD and MSc training, as well as relevant short-term orientation courses, seminars, and workshops.

5. *On information communication*

Produce and distribute technical information and promote the immediate publication of research findings for the use of decision-makers.

National programs for dealing with impending water-hyacinth problems have so far been extremely slow to adopt such recommendations, and control efforts have often been uncoordinated. Such infestations have grown from small to crisis situations without effective action being taken to combat them. One explanation advanced for this has been that people at high political and bureaucratic levels have no awareness of the scope of the problem before a crisis occurs. Furthermore, most countries in AME have no centralized decision-making bodies to deal quickly and effectively with such problems. As a result, these countries usually provide no budget for routine surveillance. Also, delays occur in soliciting and releasing funds to manage water-hyacinth crises when they occur. It is therefore not surprising that most outbreaks are dealt with on an ad hoc, "fire-fighting"

basis, often in response to outcries from the community, during which time the crisis often worsens. The responses have usually been reactions to crisis events, rather than anticipation of emerging problems.

It is important to design national programs for water-hyacinth control to overcome these obstacles, such as by

- Ensuring early recognition of the potentially serious consequences of weed infestation at the highest political and administrative levels;
- Establishing a single organization in the affected country, with full responsibility for dealing with the weed problem and coordinating the efforts of other stakeholders;
- Providing adequate funding through routine budgeting;
- Drafting regulations to prevent the introduction and spread of water hyacinth; and
- Streamlining procedures for registering herbicides with positive environmental attributes and for importing biological-control agents.

This workshop should also review and make recommendations on the availability and accessibility of information on water hyacinth, especially on control options and their effectiveness. This would help to ensure informed decision-making.

Participants in this workshop are aware that the spread of water hyacinth respects no international boundaries. It is also clear that only joint action will lead to sustainable and cost-effective control, especially where countries share infested water bodies. However, it is not so obvious how such countries can

- Jointly develop action proposals based on cooperative assessments of regional or Africa-wide water-hyacinth threats;
- Exchange information, share expertise, formulate and integrate joint training programs, facilitate cross-border surveys, and harmonize regulations for the introduction of biological-control agents;

- Establish early-warning systems for initial infestation, movement, and rate of control of water hyacinth in AME; and

- Team up to seek and muster financial support for joint action.

Participants in this workshop have been challenged to think of a mechanism for communicating information — like an information clearinghouse — that would facilitate interaction among key players and countries facing common problems with water hyacinth. Such an initiative could also be used for facilitating communication on ongoing efforts and results of research in various countries, as well as for supporting other mechanisms, such as newsletters and workshops. In addressing this challenge, participants should consider the following questions:

- Would the establishment of a coordinating and clearinghouse mechanism be a useful first step in improving the interaction and effective decision-making of the key players?

- If so, what should its mandate, functions, and main activities be?

- Would these contribute to coordination of information flow, as well as to monitoring and evaluation of control efforts?

- How can such a mechanism be established and sustained?

- What other continental or regional mechanisms might it complement?

Conclusions

Water hyacinth poses a real threat to important water bodies in AME. The economic consequences may soon become extremely serious in areas where they have not already been so. The participation of every member of the public is needed to bring the weed under control.

The crisis in Lake Victoria urgently requires an effective control strategy for water hyacinth. Researchers should make efforts to deal with the deeper and systemic problems that are the real cause of the weed explosion in most aquatic environments. Handling the immediate crisis would be straightforward, given that

current knowledge is sufficient. The expertise in the region may be adequate to handle the weed problem if mobilized in time and equipped appropriately. The question is, how can it be accessed by those who need to use it?

Six activities that require immediate action are

- Getting rid of the gross accumulation of the weed as quickly as possible;
- Intensifying the multiplication and release of biological-control agents as a major component of an integrated, long-term control strategy;
- Putting money into research on water-hyacinth growth, propagation rates, and dispersal dynamics;
- Building the necessary capacity to facilitate water-hyacinth control;
- Defining the socioeconomic and environmental problems posed by water hyacinth; and
- Establishing an information clearinghouse for AME.

We should remember that what has brought us here is the need to (1) identify ways to improve the capability of communities, their authorities, and supporting organizations to respond to, and effectively handle, the water-hyacinth problem in the freshwater bodies of AME; and (2) improve communication and interaction among researchers, decision-makers, and representatives of other stakeholder groups. Only in this way can the water-hyacinth menace in AME be brought under control.

Finally, I wish to take this opportunity to thank the organizers of this workshop and IDRC for inviting me to give this keynote address and participate in this workshop. Of course, I also thank all of you for devoting all or some of your time to the problems of water hyacinth. This workshop would not be possible without your participation. I also wish to assure you that my interest in water hyacinth will not wane until we have a coordinated solution to the problems it causes on the African continent.

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Chapter 9

WATER-HYACINTH MANAGEMENT CAPABILITY IN AME

KEY ISSUES EMERGING FROM SURVEYS AND CASE STUDIES

George Phiri, Luis Navarro, Magzoub Bashir, Carina Cilliers, Ousseynou Diop, Yahia Fayad, and Ahmed Khattab

Introduction

Although water hyacinth is firmly established in inland water bodies of the AME region and threatens the use and conservation of water, efforts to manage the weed have not been prompt. The region has not fully mobilized its own existing knowledge and capabilities or those beyond the region to control the weed. Decision-makers, researchers, representatives of communities, and other interested parties usually differ in their perceptions, expectations, and preferences regarding the options available for combating water hyacinth.

The 1996–97 survey and case studies confirmed this state of affairs. The general objectives of the consultation were to assess the knowledge of, capabilities for, and main bottlenecks in the effective control of water hyacinth; enhance awareness among stakeholders of the socioeconomic and environmental consequences of water-hyacinth infestation; and stimulate the search for effective mechanisms to mobilize people, expertise, and resources to control water hyacinth effectively in AME.

Summaries of the consultants' reports were presented in plenary sessions during the workshop. This discussion highlights the key issues that emerged from the consultants' presentations.

Methodology

The IDRC regional offices in AME coordinated the consultants' work. Three consultants covered North Africa and the Middle East, especially Egypt and Sudan. One covered eastern and southern Africa; two covered West Africa; and one covered Namibia and South Africa. The survey instrument (Appendix 1) provided major guidance for the consultants. They visited selected libraries and institutions to survey key informants and assess the available information on water hyacinth.

Key findings from regional reports

North Africa and the Middle East

Egypt

BACKGROUND — Egypt has the oldest record of water hyacinth in AME. People distributed it as an ornamental plant for public gardens in the vicinities of larger towns, such as Cairo, and in the Nile Delta in the late 1890s and early 1900s (Muschler 1912; Gopal 1987) (although Simpson [1932] reported its presence much later). Before the construction of the High Aswan Dam, the main Nile channel was relatively free of the weed, as it was frequently flushed downstream by annual floods. The impoundment of the river slowed the flow of the Nile. Water hyacinth has since then accumulated and spread widely through the country's extensive network of drainage and irrigation canals fed by the Nile and throughout the delta. Infestation in the Nile River between Aswan and the Mediterranean Sea reached a peak of 8 400 ha in 1983. Following various control efforts, the level of infestation decreased to about 380 ha in 1992. Recent statistics show that infestation is on the increase again, with almost 5 000 ha recorded in 1996. According to surveys conducted under the Water Hyacinth Management Capability in Africa and the Middle East project, the High Aswan Dam is free of water hyacinth, although small infestations occur 12 km north of the dam. Infestation levels increase northward toward the Nile Delta and the large lakes of Maraud, Edco, Manzala, and Brolos in the north, and these levels of infestation seriously affect farmers and fishers.

EFFORTS TO CONTROL WATER HYACINTH — Egypt initially relied on chemicals to control water hyacinth. It stopped chemical control in about 1990–91, because of environmental concerns.

Egypt has considered biological control but has not fully implemented it. In collaboration with the United States Department of Agriculture (USDA), it

introduced exotic biological-control agents, evaluated the agents, and conducted host-specificity tests in quarantine during 1978–84. However, it never released these agents to control the weed. To date, Egypt has not adopted the use of these agents for the biological control of water hyacinth — the method is still under review.

Since 1991 Egypt has depended exclusively on physical methods to control water hyacinth. Its Ministry of Public Works and Water Resources (MPWWR) has executed mechanical harvesting and barriers, such as floating booms, in the main channel and claimed success. Farmers remove water hyacinth manually from the small canals that form the net of farm irrigation and drainage systems, but the weed remains a menace.

MPWWR is solely responsible for control of water hyacinth in Egypt but has little dialogue with other stakeholders, such as the Plant Protection Research Institute (PPRI) (under the Ministry of Agriculture and Land Reclamation) and universities.

Egypt has a strong expertise on alternative methods for water-hyacinth control. Such expertise can be found at PPRI, including the knowledge of biological control that Egypt could use to develop an integrated water-hyacinth management strategy. However, an integrated strategy has not developed, owing to a lack of interinstitutional collaboration and national coordination.

Sudan

BACKGROUND — Sudan probably has the longest history of water-hyacinth control in AME. The weed was first discovered near Bor town about 1954, presumably having invaded from the Congo River, where it had spread since 1952. In 1958–59, Sudan declared it a pest, like the desert locust and Quelea birds that feed on grain, and then put legislation in place to control it. Water hyacinth breeds continuously around Juba–Malakal, is discharged through Malakal–Kosti, and is lodged over a further 300 km down the Nile. Sudan has partially evaluated the socioeconomic costs of water hyacinth, estimating that the annual water loss from evapotranspiration over 300 km^2 of canal would be enough to irrigate more than 400 ha. Effects on navigation in the Nile include 50% higher running and maintenance costs and 30% more use of fuel. The cost of chemical control alone over 15 years would have been in excess of 19 million United States dollars (USD).

Investigations have shown that it is feasible to use water hyacinth for biogas production, mulching, and animal-feed supplementation.

EFFORTS TO CONTROL WATER HYACINTH — Sudan initiated efforts to combat the weed in 1959, giving responsibility for this to the Water Hyacinth Control Division under the Plant Protection Department of the Ministry of Agriculture. Priority was given to easing the constraints on navigation. The initial control strategy was chemical, using 2-4D. This cost almost 1.5 million USD annually. Sudan terminated chemical control in 1983.

Sudan has used physical methods but considers them expensive. Using casual and permanent labourers for manual removal costs almost 160 USD/ha, for instance, and using a prototype mechanical harvester costs almost 115 USD/ha. In nearly all cases, manual removal has not effectively controlled the weed. But using labourers does have the secondary benefit of providing employment.

The Plant Protection Department, the National Council for Research, and the University of Khartoum carried out a project using biological control. The United Kingdom Overseas Development Administration (now DFiD) partially financed this project through the Commonwealth Institute of Biological Control (later known as IIBC and now as CABI Bioscience). Two species of *Neochetina* weevils were released and established, together with the moth *Sameodes albiguttalis* (Warren), in 1978–79. Over a long time, the vigour and productivity of the water hyacinth were reduced to levels at which the weed was no longer a navigation constraint for boats and barges. The cost of biological control was 1 million USD over a 5-year period.

Water hyacinth is presently considered to be under control in Sudan.

West Africa

Surveys in West Africa included consultations and visits to seven countries with known water-hyacinth infestations. Nigeria is discussed in this section, as it provides a classic example of the weed problem in the region. Benin is the focus of a case-study summary.

Nigeria

BACKGROUND — Nigeria recorded water hyacinth for the first time in 1984 in Badagry Creek. Presumably, it had spread from neighbouring Benin, where it had been reported earlier. The weed has now spread to most rivers of southern Nigeria and to Lake Kainji in Niger State (the lake is important for hydroelectricity production). The rapid spread of the weed in Nigeria is attributable to human transportation and to the interconnection of water bodies.

Nigeria is host to the Economic Community of West African States (ECOWAS), which recently developed a regional project on aquatic weeds,

including water hyacinth. The broad objective of the project is to protect, rehabilitate, and improve the biodiversity of water bodies in the region, with a view to conserving the environment. The project has six main components:

- Coordination of regional efforts to control aquatic weeds;
- Integrated control of aquatic weeds on the shorelines of Benin and Nigeria;
- Integrated control of aquatic weeds in the Niger River basin (also covering Benin and Nigeria);
- Integrated control of aquatic weeds in the upper Niger River (covering Mali);
- Integrated control of aquatic weeds in the Tano River (covering Côte d'Ivoire and Ghana), and
- Integrated control of aquatic weeds in the Senegal River basin (covering Senegal and Mauritania).

Although ECOWAS emphasizes biological control, the need to coordinate physical means, such as mechanical removal, is also necessary.

EFFORTS TO CONTROL WATER HYACINTH — Once water hyacinth was detected in the country, the Nigerian government formed a national committee on water hyacinth and housed it in the National Agency for Science and Engineering Infrastructure (NASENI). Through five subcommittees, the national committee is responsible for monitoring the development of the weed and implementing mechanical, chemical, and biological control, as well as investigating the weed's potential uses. Coordination of control efforts is the responsibility of NASENI, but the national committee has representations from universities, the National Institute of Horticulture (NIHORT), the Fisheries Department, and the Federal Agency for Environmental Protection. The annual work plan implemented by the national committee has a budget of only 18 000 USD, funded solely by the federal government.

Nigeria has preferred physical methods to control water hyacinth. These include manual removal (mainly organized at the community level) and mechanical harvesting. The manual method has been used along the shorelines of rivers

and canals but appears to have been unsuccessful, and mechanical harvesting is costly.

Chemical control has had several trials, mostly conducted by the Institute of Ecological Studies, Obafemi Awolowo University. Of the herbicides tested, glyphosate killed the weed without toxicological effects on the fishery. Because of environmental concerns, however, the Nigerian government is not favour of chemical control. NIHORT has also used biological control. It has imported the water-hyacinth weevil *Neochetina eichhorniae* and released it into the Niger River since 1993. Some of the weevils released in Benin have also spread to Badagry Creek. The impact of biological control is not yet clear, but there is good weevil establishment, and monitoring and evaluation are in progress.

Handling the water-hyacinth problem in Nigeria seems to be hindered mainly by a slow and time-consuming bureaucracy, poor financial support, and inefficient communication and coordination. Furthermore, the national committee on water hyacinth has been ineffective and has left out some key stakeholders.

As Nigeria shares most of its infested water bodies with neighbouring states, it has moved to solicit collaboration from these countries, as demonstrated by a recent joint proposal with Benin and with Niger.

Benin

BACKGROUND — Initial infestations of water hyacinth in Benin appeared in the Ouémé River in 1980–81 but reached outbreak proportions in 1985. This river produces almost 24 000 t of fish each year and provides a livelihood for about 34 360 full-time fishers, but infestations of water hyacinth threaten this livelihood.

Benin has no national committee, like the one in Nigeria, to address the problem of water hyacinth or coordinate the activities of major actors in its management. Major institutes and organizations involved in water-hyacinth control in Benin include the Service de la protection des végétaux (plant protection service, SPV); the Projet de pêche lagunaire (lagoon fisheries project, PPL) of the Directorate of Fisheries, Ministry of Rural Development; the Beninese Environmental Agency; and IITA's Benin Station. The Beninese government, GTZ, and IITA (also partly supported by GTZ) provide most of the support for control of water hyacinth. Interviews in Benin by the consultants pointed to the nonexistence of a national coordination structure, although respondents acknowledged collaboration among IITA, PPL, and SPV. In most part this has occurred in connection with PPL, which has financing from the government and GTZ (under SPV) and technical support from IITA. A case study on PPL provided the present information on Benin experiences.

EFFORTS TO CONTROL WATER HYACINTH — In the past 7 years, interventions in Benin have relied almost exclusively on biological control. Two weevil species were released between 1991 and 1995. Establishment of *N. eichhorniae* (almost 80%) was much better than that of *Neochetina bruchi* (almost 20%). In 1993–95, the moth *S. albiguttalis* was also released, but the extent of its establishment has not yet been confirmed. People in riparian communities, particularly fishers, practice manual control. However, this has been found to be counterproductive to biological-control efforts.

Control efforts have had varied results. In sheltered sections of the river, where water flows slowly, the weevils establish well, and their impact on the weed is evident. However, where the waters are open, fast, and fed by tributaries (which act as nurseries of water hyacinth), control has been slow. As a consequence, there is no consensus among researchers and communities on whether biological control has been a success.

The Ouémé River project had too little funding to include an evaluation. PPL intended to terminate the project by March 1997, and SPV had no further plans for water-hyacinth control. IITA intended to maintain cultures of biological-control agents, but there was no clear indication of how monitoring and evaluation of the control program would continue.

South Africa and Namibia

The Orange River marks the South Africa–Namibia border. At present, Namibia has had no record of water hyacinth, whereas South Africa has had infestations since the beginning of the 20th century. Discussion in this section will therefore focus on South Africa. South Africa now hosts the headquarters of the Aquatic Weeds Sector of the Southern African Development Community (SADC), a community of southern African states that was previously under the Southern African Regional Commission for the Conservation of Soil.

South Africa

BACKGROUND — Water hyacinth was first reported in Natal, South Africa, in 1910, and from there it has spread throughout South Africa. The main areas where it occurs vary from low-lying, subtropical zones to high-elevation zones where frost is common in winter. However, about 20 000 ha of the weed is found on rivers and artificial water bodies throughout the country.

In all areas of South Africa, the phenology of the weed varies during the year, with an annual period of active growth between October and March. At high elevations, frost halts the weed's growth during winter (May–August), and its

growth is slow in the temperate and subtropical zones. Years of drought also have an effect on water-hyacinth infestations: when water levels are low and rivers flow slowly, the breeding and accumulation of the weed are enhanced. During such periods, water-hyacinth infestations completely block large stretches of rivers, lakes, and artificial impoundments. When floods occur, huge masses of water hyacinth and other riparian vegetation float away as large islands. Many wilted plants get stranded at the high-water mark, where they die. Small residual colonies and seeds then form the basis for the next reinfestation, which occurs with the inundation of the water bodies, although it usually takes several years for the weed to become a problem again.

South Africa has legislation that covers water hyacinth, the *Conservation of Agricultural Resources Act* (Act 43, of 1983), administered by the Directorate of Resource Conservation of the National Department of Agriculture. The Act declares water hyacinth a weed that must be controlled.

EFFORTS TO CONTROL WATER HYACINTH — The South African Department of Water Affairs (DWAF) has a mandate to coordinate the control of water hyacinth and to execute control measures where the weed threatens state water works. DWAF achieves this through country-wide regional offices.

DWAF initiated its control of water hyacinth in 1962, although the weed had already been in the country for 50 years. Earlier efforts relied mainly on chemical control and to a lesser degree on physical means. One case of successful chemical control started in the late 1970s on the Hartbeespoort impoundment. This effort was spearheaded by DWAF and the Council for Scientific and Industrial Research. South Africa is still implementing follow-up sprays.

In another situation in the Vaal River, aerial application of herbicides was carried out between 1983 and 1985. In 1985–86, the river became reinfested, and water hyacinth blocked large stretches of the river. This influenced a decision to attempt alternative control options.

In 1974, PPRI and the Weeds Division of the Agricultural Research Council initiated biological control of water hyacinth, importing and releasing the weevil *N. eichhorniae*. This initial effort was suspended because of a human-resource shortage, interdepartmental policies, flooding, and extensive chemical and mechanical control. The program resumed in 1985–86, when DWAF contracted PPRI to assess the possibility of using alternative control methods. Reports of success from Australia, India, Sudan, and the United States renewed interest in biological control. During 1986–96, research confirmed that *N. eichhorniae* had

established and spread to localities far removed from the sites where it was released in 1986–90 and 1994. The mite *Orthagalumna terebrantis* and the fungal pathogen *Cercospora piaropi* were present in the subtropical lowveld (Mpumalanga Province) and had spread to other parts of the country where they had been absent. Two other biological-control agents, *Neochetina bruchi* and *S. albiguttalis*, were also imported and became established.

PPRI focuses its current research on exploring and evaluating additional natural enemies for water hyacinth. These efforts have already led to the release and establishment of a new agent, the mirid bug *Eccritotarsus catarinensis*, in 1996. PPRI is collaborating with DWAF to develop a management plan for water hyacinth, integrating biological control with alternative options. Other groups implementing control in South Africa include conservation bodies, communities, and municipalities. South Africa's Water Research Commission intends to fund a collaborative study on the effect of herbicides on biological control; the study will involve PPRI and the biotechnology company Monsanto, which is interested in the problem of water hyacinth in South Africa and the rest of Africa.

South Africa is conducting an awareness campaign to draw the attention of communities and authorities to the water-hyacinth problem. The campaign involves the production of extension materials, such as posters, and popular articles in magazines and newspapers. These are being circulated widely in the country.

Over the past 10 years, owing to a growing realization of the need to collaborate and develop an integrated approach, DWAF has improved its communications with other key players in water-hyacinth control, such as PPRI and the firm Monsanto.

KEY LESSONS FROM A CASE STUDY IN SOUTH AFRICA — A case study in South Africa investigated the integrated control of water hyacinth in the Enseleni–Mposa rivers, which flow through the Enseleni village and a nature reserve. The communities and the National Parks Board were involved in the program. The program mainly used biological control and physical means (floating booms); limited chemical control was also used. The program stratified the river systems into five management units and determined the choice of method based on levels of infestation and knowledge of the weed's principal nursery sites.

The study's main lesson was that communities have important roles to play in water-hyacinth control.

Eastern and southern Africa

Background

The eastern and southern Africa region has some of AME's oldest records of water hyacinth outside South Africa and Egypt. For instance, the weed was first reported in Zimbabwe in 1934; Mozambique, in 1946; Tanzania (Pangani River), in 1960; Ethiopia, in 1965; and Malawi (Shire River), in 1968. More recent infestations in Uganda (Lake Kyoga, 1987–88) and in some of the world's most important water bodies, such as lakes Victoria (1989–90), Malawi-Nyasa (1995), and Tanganyika (1996), indicate that the scale of the problem has worsened in the region over the past 60 years.

The consultation found reports of water-hyacinth infestation in most countries in eastern and southern Africa, with the exception of Botswana, Lesotho, and Swaziland. Although these countries were not infested, there is great concern because they are susceptible to such infestations, which would hamper water availability and use, especially in Botswana. Infestation of the Okavango Delta would definitely lead to serious socioeconomic problems. As a result, extensive publicity campaigns are being conducted to create awareness of the weed and prevent people from spreading it.

In all eastern and southern African countries, water-hyacinth infestation concerns many organizations, institutes, and communities. This calls for a coordinated effort involving all concerned sectors. The weed is a problem for fishing, agriculture, domestic water supply, navigation, and hydroelectricity generation. It is also a problem for local councils, as it affects tourism and national parks and wildlife. Water hyacinth causes enormous socioeconomic problems, the magnitude and extent of which are generally unquantified.

Virtually all countries in eastern and southern Africa consider water hyacinth a problem. Countries with confirmed infestations already have organizational structures in place that could handle the problem. These include fisheries organizations, plant-protection and agricultural-research services, environmental councils and authorities, departments of national parks and wildlife, and various nongovernmental organizations. In all cases, however, the response of these organizations to the water-hyacinth issue was considered deficient.

The consultants surveyed 17 people, including researchers, policy- and decision-makers, and representatives of communities from seven countries, regarding access to information on water hyacinth. All seven countries had weed infestations or were actively involved in finding solutions to the problem. The results show that, generally, the region has information on water hyacinth, but it is not readily available to those who need it. More than two-thirds of those working on

water hyacinth had access to some form of information on the weed, but less than one-third had access to electronic sources of information on water hyacinth, such as CD-ROMs. Generally, access to modern electronic methods of communication was inadequate: only one-quarter of those interviewed had access to e-mail (two-thirds had access to fax).

Efforts to control water hyacinth

Although water hyacinth is covered under Noxious Weeds Acts in various countries of eastern and southern Africa, efforts to effectively combat it have always been initiated late. In almost all cases, people in the region have taken action only after the spread of the weed has become a crisis. A fresh example is Lake Victoria, where water infestation has been going on for 7 years. Only recently did Kenya, Tanzania, and Uganda — countries that share this water resource — seem to be agreeing on a coordinated effort to solve the problem. In mid-1997, the World Bank, through the Global Environment Facility (GEF) and the International Development Association, approved funding for LVEMP in these three countries. The project addresses several issues in addition to water hyacinth. To tackle the water-hyacinth problem properly, the three countries have attempted to harmonize their approaches on a whole-lake basis. They are now achieving this harmonization, but with difficulties. Supported by the GEF coalition, LVEMP has provided a forum and an opportunity to effect this coordination among the three countries. According to reports from participants in the workshop, coordination has advanced in each individual country, although in Uganda the effort has not been fully effective.

All eastern and southern African countries indicated that they had had difficulties responding to the worsening water-hyacinth situation. Reasons ranged from lack of or delays in funding, to indecisiveness among policymakers, to absence of an explicit policy, to lack of prompt recognition of the potential hazards.

Chemical control has been used in Zimbabwe and, to a limited extent, in Malawi but has raised environmental concerns. In July 1997 in Uganda, an environmental-impact assessment was completed and public debate conducted on the role of chemical control in combating water hyacinth. The assessment was inconclusive — more time is needed for further investigation.

Physical methods of water-hyacinth control have been variously employed in eastern and southern Africa. Uganda has used a physical barrier and mechanical harvesters at Owen Falls, but no one has yet fully evaluated their success or cost. People in the region have also used manual removal, most extensively in Uganda

and Zimbabwe's Lake Chivero. Results show that limited physical removal has a role to play in clearing access to specific points in infested water bodies but may not be a long-term solution.

Most eastern and southern African countries are currently implementing biological control. The water-hyacinth weevils *N. eichhorniae* and *N. bruchi* are being reared and released in most infested water bodies. The initial releases were in the early 1970s, as in the Caborra Bassa in Mozambique, and extensive releases began between the late 1980s and the 1990s in Kenya, Malawi, Tanzania, Uganda, Zambia, and Zimbabwe. Collaborators have included IITA, CABI, and USDA, with support from USAID, CSC and DFiD, and GTZ. Successful biological control has been claimed from releases in Lake Chivero. The moth *S. albiguttalis* was also released recently in Malawi, Zambia, and Zimbabwe, with collaboration between national programs and PPRI (of South Africa) and CABI. The mirid bug *E. catarinensis* was released in Zambia and Malawi in 1996–97.

Lake Chivero, case study in Zimbabwe

Lake Chivero is near Harare in Norton, Zimbabwe. The lake (originally known as Lake McIlwane) was built to serve as the main source of water for Harare's 2.5 million people. Located within the 2 136-km^2 catchment area of the city, it receives effluent from the city, suburbs, industries, and homes. Water samples from the lake show unacceptably high levels of such minerals as nitrates and phosphates.

The following events were recorded in the Lake Chivero case study:

1937	Water hyacinth is reported from one of the tributaries of the Manyame River system near Harare
1952	Lake Chivero is built in Norton, near Harare, to supply water to Harare (but it immediately becomes heavily polluted, because it is in the Harare catchment area)
1957	Water hyacinth is reported in Lake Chivero; first use is made of 2,4-D
1960	Water hyacinth is considered to be under control
1971	The lake is deemed to be hypertrophic
	Water-hyacinth infestation is considered an outbreak
	Foreshores of the lake are confirmed to have bilharzia-related snails, and a national regatta is cancelled
	A strong campaign is conducted against 2,4-D, resulting in claims of increased frequency of abortions and possibilities of giving birth to deformed babies
	Mechanical harvesting is used
1985–87	More than 420 000 USD is spent on physical and mechanical methods to control water hyacinth and *Pistia*

1986	Water-hyacinth infestation is considered a second outbreak
1986	Glyphosate is sprayed from November on; 36 knapsack sprayers are employed
1987	Glyphosate spraying is halted
	Mechanical harvesting with a crane is used
1988	Manual removal is undertaken
1990	In January, *Neochetina* weevils are released in five selected sites
	In April, establishment of *Neochetina* weevils is confirmed, and their spread becomes evident
	In August, 2,4-D and glyphosate are massively applied because water hyacinth covers 35% of the lake and exerts pressure on the dam wall and irrigation pipes
	Farmers indicate damage to irrigation structures caused by weed infestation
1990–94	About 1.3 million USD is spent on physical removal and chemical control
1991	Massive fish deaths are reported
1992	In August, a site for monitoring biological control is identified following an agreement between the Ministry of Land, Agriculture and Water Development and the Ministry of Environment
	In November, an increase in the weevil population to 0.4 adults per plant is recorded
1996	Establishment of *Neochetina* weevils on almost 100% of the water-hyacinth plants in Lake Chivero is confirmed
	Impact of biological control on the weeds becomes obvious, as sizes of mats are greatly reduced, weevil population has increased to 4–5 adults per plant, plant vigour is severely reduced, and proportion of flowering plants is down to 15% of the total weed
	Massive fish deaths are reported
1997	Coverage of the lake by water hyacinth is reduced from 35% at its peak to less than 4%, but several explanations such as flooding and impact of the weevils are suggested
	Manual removal of the weed continues until July; during this process, weevils are also being removed and dumped on dry ground, negatively affecting their performance

LESSONS FROM THE LAKE CHIVERO STUDY — Water hyacinth has been in Lake Chivero for four decades. Outbreak years have often coincided with drought years, during which the weed proliferates. Coverage of the lake reached a peak of 35% in the early 1990s. The weed was associated with an increased incidence of bilharzia, which led to the cancellation of the national regatta. Water hyacinth also significantly interfered with fishing and water pumping, threatened the dam wall, and caused significant damage to irrigation structures. Massive fish deaths were reported in 1991 and 1996 but could not be attributed directly to the weed because of the high levels of other pollutants flowing into the lake.

Spraying water hyacinth with 2,4-D in the early 1970s generated an outcry and claims of increased abortions and deliveries of deformed babies. This shows, in the extreme, the social problems associated with the weed. There is good understanding of the range of socioeconomic and environmental problems stemming from the weed in Lake Chivero, but not of their ultimate and full consequences. However, these consequences must be understood and assessed before the direction of interventions in the fight against water hyacinth can be set.

The Lake Chivero case study highlights the need for a coordinated whole-catchment handling of the water-hyacinth problem. Control of the weed in this lake should integrate management of the entire catchment, including upstream sections of the Manyame River, which is the source of reinfestation. It also requires a well-planned awareness-raising campaign to inform stakeholders of the progress in problems and in the efforts to control them. Proper identification of stakeholders, which must include riparian communities, is also a critical consideration.

An active lake-users association for Lake Chivero is deeply concerned about the water-hyacinth infestation and its control. However, it does not appear to be part of, or influential in, any decision-making process regarding the control efforts coordinated by the Department of National Parks and Wildlife. This case study also suggests the need to implement control efforts systematically, with well-planned monitoring and evaluation of the growth of the weed, the impacts of the control efforts, and the status of the aquatic environment. It is also clear that control programs should incorporate a quantification of the weed's socioeconomic and environmental consequences.

Key suggestions and recommendations from the consultations and survey in AME

1. National programs should build effective institutional frameworks to coordinate activities for control of water hyacinth. Such frameworks should facilitate the participation of all major stakeholders (government, non-governmental organizations, politicians, affected communities, and centres of expertise).

2. Mechanisms should be set up to improve the acquisition and flow of water-hyacinth information among those implementing control. Consideration should be given to supporting modern methods of communication, as well as facilitating access to modern sources of information.

3. The interaction of researchers, decision-makers, and communities in dealing with water hyacinth should be improved at national and regional levels.

4. Dialogue between countries sharing water bodies should be improved to facilitate the implementation of control on a whole-water-body basis and to harmonize efforts.

5. An effective and practical, integrated control strategy for water hyacinth should be developed and implemented as quickly as possible.

6. Catchment-basis programs for water-hyacinth control, monitoring, and evaluation should be encouraged and established.

7. In-depth information on water hyacinth, its related problems, the urgency of infestation, and available control options should be imparted to decision-makers to enable them make effective and informed decisions for handling the weed problem.

Open plenary discussion

This open plenary discussion addressed key issues in the consultant reports and presentations, as well as those from the keynote address and the workshop's opening and introductory statements.

QUESTION — Are we not putting too much emphasis on biological control as a method to combat water hyacinth, as the weed continues to spread even after this has been implemented?

RESPONSE 1 — In any weed situation, you assess the problem and your resources before deciding what to do. As an example, in situations of a small cover of less than 1 ha, one would advise the use of chemicals or physical removal. Second, if shoreline access to villages is blocked, the most reasonable thing to do for immediate relief is physical removal. However, for long-term cheap and sustainable management of a large infestation, biological control becomes the more likely and wise choice, especially where both financial and material resources are hard to come by. Furthermore, it should be noted that in such infestations the question of eradication does not arise, as neither chemicals nor mechanical methods can achieve this.

RESPONSE 2 — To date, two weevil species have been used widely and have not been able to control water hyacinth to desired levels. One reason for this is that biocontrol has often come into the picture when water hyacinth has already reached a crisis level. There

are new biological-control agents being released — one mirid bug, two moths, one grasshopper, rust, and other pathogens. Combined, they can keep a small population of water hyacinth small. Therefore, the challenge is to rapidly reduce the water-hyacinth population so that the combined efforts of biological-control agents will keep populations small. Mechanical control is limited in areas where it can work and in the volume of the weed it can remove. Herbicide-spraying to rapidly reduce a water-hyacinth population, together with all available biological-control agents, must be the eventual solution.

RESPONSE 3 — Biological control can only be effective on smaller populations of the weeds as it is advocated by its champions. There is, however, a need to work harder on physical control before introducing biological-control agents as a means of dealing with large infestations. The two together will certainly help control the weed in the long run.

RESPONSE 4 — Biological control is the most cost-effective, sustainable, and environmentally friendly of all the available control methods. As a long-term measure, it has been found effective in several countries.

RESPONSE 5 — Biological control: why the emphasis on biological control? Introduction of natural enemies to establish an ecological interaction of prey–predator relationship is needed for long-term control of water hyacinth. Integrated control methods can still be adopted, but based on this option.

RESPONSE 6 — I think the answer to this is yes. Presently, a lot of resources are being pumped into this biological-control option without giving similar attention to alternative methods — manual, mechanical, chemical. If these methods are given the same attention, they would probably demonstrate a performance that is equally as good as or even better than that of biological control. I suggest that some attempt be made to scientifically ascertain the efficacy of mechanical methods. Chemical control, for reasons that are too long to explain here, can be ignored for now.

QUESTION — Bioagents are living things and are capable of mutation. How would we handle a situation where a mutant variety developed that was dangerous to economically important crops not considered during host-specificity tests? Whereas a limited number of bioagents can be allowed for long-term control, excessive introduction of multispecific biocides should be done with caution, because once they are out in the environment, it is never possible to exert control over them, and they will soon cause biopollution.

RESPONSE 1 — The track record of the biological control of weeds is good. (In excess of 800 species have been released worldwide over 80 years, and no unpredicted mishaps have occurred.)

Very few (less than 0.01%) of native insects on native plants have moved to exotic-crop plants (such as maize) in situations of extensive monocultures. The few native insects that did move over to become pests are polyphagous (not the types of insects that would be used in biological control). This demonstrates the high level of host specificity of phytophagous insects in general.

Maybe the important point is to take risks — including those of biological control. The risk in this case, however, is small and cannot be outweighed by the damage and cost caused by really heavy infestations of water hyacinth. Even in biological control, we do undertake risk–benefit analyses, as all forms of decision-making in life are based on risk–benefit analysis.

QUESTION — There is a need to input research information into management strategies, either those in use or those being considered. Hence, there is an urgent need to obtain relevant information on the impact of water hyacinth on social, economic, and environmental aspects of water resources, such as those related to fisheries, to set levels and methodologies to control the weed. We need to answer the critical question, What is the desired level of control of water hyacinth in a specific environment, and how would it be determined?

RESPONSE 1 — The problem of water hyacinth is ill-defined. More emphasis definitely needs to be placed on quantifying the effects of the weed on biodiversity, fisheries, water quality, and disease vectors. These data are needed to enable donors and governments to make rational decisions in allocating resources to weed control and determining the effects of control measures.

RESPONSE 2 — One of the environmental issues associated with water hyacinth is vegetation succession in aquatic systems. Water-hyacinth accumulation provides a substrate for the growth of other plants, such as hippo grass, and this worsens the weed problem in wetlands. In the absence of water hyacinth, these other plants would be unable to grow. Environmental studies of water hyacinth should therefore cover this aspect as well.

QUESTION — Can we be as clear on equipment and methods for physical or manual control as we are on those for chemical and biological? The reason why not much data have been generated or disseminated on any of the successes of the three methods for water-hyacinth control is the lack of knowledge on

- Who is responsible for controlling water hyacinth;
- The funding mechanism; and
- Local initiatives and any arrangements for the continuity of the efforts being implemented.

RESPONSE 1 — A modular weed-harvesting system consisting of a take-out elevator, transfer conveyor, and dump trucks costs about 500 000 USD, as a single system. Operating costs are, however, not included in this estimate.

RESPONSE 2 — Since the stoppage of chemical weed control in 1991 in the Nile River, drains, and canals, Egypt has been applying mechanical and manual removal methods. These are as follows:

- Mowing buckets (instead of dredging buckets) are used to keep the cross section of canals and drains to the original design specifications (this can be altered or enlarged by using dredging buckets).
- Improved hand tools prevent labourers from coming into contact with water hyacinth, thereby minimizing the risk of bilharzia. This method is used in areas without road access for mechanical harvesters.
- A new and successful approach, experimented on 2 years ago, involves farmers in weed control through the formation of water boards — using what we call "length man system" — where the farmers clean the canals by themselves

all year round. The farmers like to keep their canals clean so that they have sufficient irrigation water at the tail ends of the canals. This is being done in six pilot areas and is likely to spread to all the canals.

- Biological control using the grass carp for submerged weed has also been adopted.

RESPONSE 3 — After our participation in this workshop, during which we have interacted with experts on water-hyacinth from the rest of Africa, I would like to indicate here that we will immediately support the field application of biological control of the weed in Egypt, as is happening in the rest of Africa, particularly the use of the two weevil species.

RESPONSE 4 — I am not sure if the techniques of mechanical harvesting developed and used in Egypt can be relevant to the situation in Lake Victoria, which has an area of 68 000 km^2. There are several other large waterways where they may not be appropriate. To the best of my knowledge, the problems with chemical control in Egypt arose mainly from use in controlling rooted aquatic macrophytes in irrigation channels, and not really in controlling water hyacinth.

RESPONSE 5 — The issue is the insufficient or inaccurate data on efficiency and reliability of the methods used. For example, there is no evaluation of the methods advocated at present. This is reflected in the form of differences of opinion. The main issue is difference of opinion, as well as lack of scientific information to base decisions on.

RESPONSE 6 — There is a definite information gap between those who know and those who do not know. This has often led to distortion of water-hyacinth information and hindered the success of control programs.

QUESTION — All the consultant presentations highlighted the difficulties in developing coordinated efforts to combat water hyacinth. Often, vested interests have overtaken pragmatism and objectivity. There have also been concerted efforts to "sit on the fence," waiting for somebody to take the lead and point fingers at inaction. How can this problem be addressed?

RESPONSE 1 — The Lake Victoria Environmental Management Project, involving Kenya, Tanzania, and Uganda, has encouraged the establishment of policy and steering committees for the control of water hyacinth in each country and a regional coordination committee at the project level. The committees facilitate linkages from regional, through national, to district-community levels. The same channel is used to disseminate critical information, say on control measures to be developed and adopted.

RESPONSE 2 — There is need to look at extension services in various countries to improve information flow from researchers to communities and vice versa, rather than having no effective link between research and extension service.

RESPONSE 3 — A possible solution for improving coordination of water-hyacinth control efforts is to have common forums and committees of all stakeholders for

- Coordinating research and control efforts;

- Coordinating sourcing of local and external funds;

- Providing technical advice on control strategies;
- Identifying and approving collaborating local and external institutions; and
- Advocating action to execute effective control and less talk.

RESPONSE 4 — There are very different levels of expertise and development of biological control of water hyacinth in different countries. The measurements of the success of biological control are also very few — for instance, measurements that relate released agents to investments made and other parameters.

There is also an inconsistent placement of chemical control within various national programs. In most cases, the environmental impacts of various chemicals are inadequately researched, if at all. As a result, sentiments expressed against chemical control are usually panic responses. My opinion of this is that chemical control is the most cost-effective and straightforward measure.

Furthermore, there is little attention paid to water-hyacinth utilization as a means of deferring the costs of control. It is not known whether utilization is economically infeasible or it has merely been overlooked. We have developed a research program for water-hyacinth utilization at Makerere University in Uganda and hope to address this issue.

RESPONSE 5 — Information on how to use water-hyacinth plants harvested by mechanical and manual methods will be important, particularly in encouraging community participation in the beneficial utilization of these plants.

RESPONSE 6 — In Uganda, the disadvantages of water hyacinth far outweigh any advantage that could ever accrue from its utilization; hence, the only option is control. However, when utilization derives from a control operation, such as using mechanically harvested plants, that should be welcomed, and investors in technology development need to be sought.

COMMENT — Water hyacinth is a symptom of broader watershed management and pollution problems, and not the real problem. None of the presentations dealt with causes of weed proliferation such as pollution when it came to water-hyacinth control. No presentation dealt much with community involvement, either. There is also a need to discuss what works, what does not work, and how methods can be improved.

RESPONSE 1 — Methods for water-hyacinth control should include reduction of nutrients in the water bodies. It is true that the weed multiplies because of nutrients being discharged into the rivers and lakes. For instance, waste-water treatment should be improved in situations where waste water is poured directly, and in raw form, into water bodies and encouraging the proliferation of water hyacinth. Therefore, water-quality management should be taken seriously.

We need to involve communities in the management and control of the weed so that they appreciate that this is an environmental problem they should be concerned with. Information exchange and dissemination should also involve the communities affected by the weed so that they can appreciate what researchers and the government are doing to control water hyacinth.

RESPONSE 2 — I wish to agree with the view on community participation, as I feel the top–bottom approach often employed in crisis situations will not work in water-hyacinth control.

RESPONSE 3 — Interpretation of scientific observations should take into account third-order factors that may affect or stress the weed (water hyacinth being a first-order factor; biological-control agents being second-order factors; and nutrient input, drought, floods, or other environmental variables being third-order factors).

QUESTION — What data do we have to link increases in snake bites and bilharzia and malaria cases with water hyacinth? I would like to share with those who have these experiences.

RESPONSE — The link between water hyacinth and bilharzia and malaria-carrying mosquitoes is well-known, and there are several references on this. In the Lake Victoria infestations, local communities cite increases in the number of snakes, some of which could be poisonous. In other situations, increases in the incidence of crocodile attacks have been attributed to heavy infestations of the weed, which provides cover to the reptiles.

At the end of the discussion, a site visit to the Nairobi Dam, which was then choked by water hyacinth, was suggested. Participants visited the dam.

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Chapter 10

Recommendations on Management of Water Hyacinth in AME

A consolidated report

George Phiri and Luis Navarro

Introduction

During consultations under the Water Hyacinth Management Capability in Africa and the Middle East initiative, surveys were conducted in 29 countries, and at least 21 of these countries indicated having water-hyacinth problems. Presentations from consultants during this workshop revealed that among the countries with confirmed infestations, at least 16 are implementing various control efforts. These efforts are mostly based on biological, physical (mechanical harvesting, erection of physical barriers, and manual removal), and chemical control. Consultations further showed that virtually all these countries failed to implement control until after water hyacinth has started causing problems and such problems had reached crisis levels, even though information on methods to control the weed was available in AME and global centres of expertise.

The consultants further investigated the major causes of this inaction and reported these at the plenary session. During this workshop, issues raised in the keynote address, consultants' presentations, open plenary discussion, and narration of experiences of national programs and institutions were considered by working groups. The objective was to identify the main gaps impeding the mobilization, organization, and equipping of people to effectively control or manage water hyacinth. The groups were to formulate recommendations for immediate and longer term research and implementation as an initial step in the search for effective mechanisms to respond to water hyacinth across AME.

Methodology

Participants formed three working groups to review information from earlier sessions, as well as their own experiences, and to provide working-group reports with recommendations for further plenary discussion. (The terms of reference for the working groups had been discussed in an earlier session.) After revision based on open plenary discussions, the reports of the three working groups were consolidated in this single report for these workshop proceedings.

Missing links and opportunities for effective handling of the water-hyacinth problem across AME

Working groups identified weaknesses related to access to information on water hyacinth, implementation of control, and lack of research on certain aspects as the gaps that explain why countries across AME are not promptly taking advantage of existing knowledge and capabilities. These gaps call for action to effectively mobilize, organize, and equip decision-makers, researchers, a..d representatives of communities, along with their organizations and institutions, to improve their response to the water-hyacinth problem.

Access to information on water hyacinth

The working groups acknowledged the consultants' conclusion: centres in AME and beyond have a wealth of water-hyacinth information, but this information is not easily accessible to key decision-makers, policymakers, researchers, and representatives of affected communities. Although they might need it to mobilize and execute effective control of water hyacinth and evaluate their own programs, they have difficulty accessing information on such aspects as the following:

- The actual water-hyacinth problem and the type and magnitude of its socioeconomic and environmental costs;
- The available alternatives for control of water hyacinth, their effectiveness and costs, and what to expect from their adoption; and
- Experiences from within the region and the rest of the world of effective handling of the weed problem.

Implementation of control

The working groups acknowledged observations made during consultants' presentations that serious problems were affecting the implementation of effective water-hyacinth control in most countries across AME. The major weaknesses identified as impeding prompt and effective response were

- Lack of policies on water-hyacinth handling at national and regional levels that
  - Acknowledge water hyacinth as a problem and promote its control or aggressive utilization,
  - Specify institutional responsibility for water-hyacinth management, and
  - Identify and allocate financial, human, and material resources for the establishment of control programs;
- Lack of strategies for effective and prompt response to water-hyacinth infestations; and
- Lack of coordination within communities, agencies, and organizations at the national, regional, and continental levels and across these levels.

Lack of research on certain aspects

The working groups also acknowledged that although a lot of research has been conducted on water hyacinth globally, significant gaps persist on specific aspects of the weed, such as the following:

- *Effectiveness of available control methods* — Available methods for water-hyacinth control are based on biological, chemical, and physical measures. Although these methods have been variously used, participants did not precisely know their relative effectiveness in various situations. Furthermore, each one of these approaches has strengths as well as weaknesses. Although there is consensus on the need to combine more than one of these methods in an integrated strategy, no one has undertaken research to develop this integrated approach.

- *Quantification of the socioeconomic and environmental consequences of water hyacinth* — It was clear from the consultants' presentations and the plenary session that, although water hyacinth causes serious disruptions in the use of water bodies, the exact magnitude of the social, economic, and environmental problems it causes is poorly understood in AME and in the rest of the world. Research is urgently needed to quantitatively define what infestations of the weed represent and to prompt action.

Recommendations from the working groups

Immediate action

The working groups unanimously recommended the immediate formation of a Water Hyacinth Information Clearinghouse as a useful first step in addressing issues of water-hyacinth information, its accessibility, and the interaction of key players.

Mandate of the Water Hyacinth Information Clearinghouse

The mandate of the clearinghouse should be the following:

1. Collate and disseminate global and continental information on water hyacinth.

2. Develop a database on activities related to water hyacinth across AME and their objectives, expertise, and support.

3. Assist in organizing meetings on water hyacinth, such as seminars and workshops.

4. Complement and support other information-flow mechanisms, such as an African water-hyacinth newsletter and water-hyacinth websites.

5. Commission studies in gap areas, such as the quantification of the socio-economic impacts of water hyacinth, especially on communities.

Establishment and sustainability

The following were the working-group recommendations regarding the establishment and sustainability of the Water Hyacinth Information Clearinghouse:

- *Location* — Initially, in accordance with IDRC's offer, the Water Hyacinth Information Clearinghouse should be hosted in IDRC (at least for the first 2 or 3 years) until a suitable location is identified based on centrality, cost-effectiveness, and reliable funding.

- *Modality* — In its functioning, the clearinghouse should use the existing structures of information flow as much as possible.

- *Partners* — During the establishment and operation of the clearinghouse, IDRC should develop partnerships with other donors interested in water hyacinth and with continental centres of expertise in information issues, such as CABI, university systems, ICIPE, the International Union for the Conservation of Nature, IITA, the International Organisation for Biological Control (IOBC), ECOWAS, SADC, the East African Community, and national agencies such as PPRI in South Africa and PPRI in Egypt.

- *Linkages* — The clearinghouse should develop and maintain links with global organizations concerned with the environment, such as FAO and the United Nations Environment Programme [UNEP], and the Organization of African Unity [OAU]); and with global centres of expertise in water-hyacinth control, such as the University of Florida's Aquatic Weeds Centre and CSIRO.

Medium- to long-term action

The working groups made recommendations for immediate and long-term action. These mainly focused on research issues, available control options, utilization of the weed, community participation, watershed management, priorities in research, and implementation strategies.

Research issues

Addressing the issues of research is an important medium- to long-term step in effectively dealing with the problem of water hyacinth across AME. The working group's recommendations for research included the following:

- *Policy* — Consider national, regional, and continental technology policy and transfer in relation to water-hyacinth control. At each of these levels, identify, develop, and implement policy on water-hyacinth control.

- *Responsibility* — Identify key stakeholders in water resources and entrust them with control of water hyacinth (once identified, they should be key participants in water-hyacinth research and control).

- *Approach* — Determine whether water-hyacinth control should be government-based, community-based, or co-managed with a strong component of community participation.

- *Early-warning mechanisms* — Develop mechanisms for early recognition of impending water-hyacinth infestations and problems, using national and cross-border surveys and monitoring. Use these mechanisms to send early warnings of impending water-hyacinth infestations.

- *Evaluation* — Conduct research on the role of early-warning mechanisms in the evaluation of programs already in operation across AME. Document the success or failure of control efforts and implementation and disseminate this information to key players in water-hyacinth control across the region.

Available control options

Implementation of the available water-hyacinth control options at national and regional levels and across AME should be intensified. The working group proposed the following approaches:

Biological control

1. Release proven natural enemies immediately, as soon as water-hyacinth infestations are identified and confirmed.

2. Accelerate the exploration and evaluation of new natural enemies of water hyacinth.

3. Investigate the efficiency of multiple releases of natural enemies in the control of water hyacinth.

Chemical control

1. Disseminate widely in AME the results of environmental-impact assessments undertaken in some countries.

2. Conduct research to improve methods of applying herbicides.

Physical control

Physical-control methods include manual removal, mechanical harvesting, and use of floating barriers, such as cables and booms. The working group recognized that these methods have an important role to play as stop-gap measures in water-hyacinth control, especially in strategic places such as "fish landing sites" (sites where fishing boats unload fish), boat-launching sites, ports, and hydroelectricity dams.

1. Identify alternative methods, their costs, and effectiveness.

2. Conduct environmental-impact assessments. Because water hyacinth may contain up to 95% water, environmental consequences of the removed and decomposing weed must be evaluated and elucidated. Furthermore, where manual removal is encouraged, particular attention must be paid to water hyacinth's association with harmful organisms, such as snails, which are intermediate hosts of schistosomiasis. One should understand the implications of manual removal for human health and ensure adequate protection for those handling the weed.

3. Use physical barriers, such as cables and booms, for immediate, short-term control across infested rivers. Support these barriers with other control methods, such as removal of the accumulated weed, release of biological control agents, or use of herbicides.

Integrated control

AME countries need to develop management plans for water hyacinth. The plans should focus on integrated control and integrated management of water hyacinth with biological control as the first line of attack and long-term solution to the weed problem.

Utilization of the weed

People have investigated possible uses for water hyacinth for a long time. Although it is not considered a control option, it may play an important role where communities use physical removal. They should be warned, however, not to transport the plants to noninfested areas.

Community participation

Riparian communities on infested water bodies should be involved in appropriate control strategies. Particular attention should be given to community mobilization, access to information, and coordination of community-based activities. Communities should also have a role to play in water-hyacinth monitoring and the creation of early-warning systems. These aspects should be covered in training programs.

Watershed management

The infestation and proliferation of water hyacinth in eutrophic waters are a catchment management problem. Causes of the enrichment of waters, such as pollution, should be investigated and corrected to reduce the likelihood of reinfestation and proliferation of the weed. Furthermore, other causes of reinfestation, such as seed banks, should be addressed as part of an integrated management plan for the weed. Watershed management should be included in a broader environmental-awareness agenda.

Priorities in research

A glaring gap highlighted in the consultants' presentations was the lack of quantification of the socioeconomic and environmental consequences of water hyacinth. In addition, evaluations of control efforts have so far been inadequate. As a result, the real problems caused by the weed are poorly understood, and so are the ameliorating effects of control. The working group recommended the following to address this gap:

1. Study socioeconomic impacts of water hyacinth on riparian communities.

2. Investigate the environmental impacts of water hyacinth, including effects on aquatic biodiversity and the abundance of aquatic organisms.

3. Determine acceptable threshold levels for water hyacinth.

4. Disseminate the results of all these studies.

Implementation strategies

A lack of structures for implementation of control at the national and regional levels has partly impeded the handling of the water-hyacinth problem in AME. Some countries, such as Nigeria and Uganda, have national committees that are entrusted with the coordination of control efforts. The rest of the region has structures to control water hyacinth, but they do not enjoy the full participation of key stakeholders. However, even the performance of national committees is questionable, as they also leave out key stakeholders. Other implementation problems relate to the lack of awareness at top political and decision-making levels of the dangers of water hyacinth and the urgency of the need for effective control or management. The working group's recommendations for implementation strategies were as follows:

Responsibility

1. Establish national institutional structures for handling the water-hyacinth problem, with linkages at both regional and global levels.

2. Assign responsibility for water-hyacinth control to a single ministerial department, but maintain full and effective liaison with other government departments, institutions or organizations, and communities with an interest in water-hyacinth control.

3. Solicit the goodwill of politicians to support water-hyacinth control and clearly indicate the expected effectiveness of proposed control efforts. Enhance this effort, if necessary, with public-information and public-awareness campaigns, including reference to reports on the social, economic, and environmental consequences of water hyacinth.

Coordination of control

1. Establish effective mechanisms to coordinate and systematically implement control efforts and to help resolve any conflicts arising among stakeholders because of diverse interests.

2. Identify stakeholders and secure their full participation.

COMMUNICATION

1. Ensure effective communication between the coordination structure and key stakeholders (because water-hyacinth problems are cross sectoral, the stakeholders within a national program should have effective channels of communication).

2. Establish effective communication channels for exchange of information between countries sharing water bodies and between these countries and regional and global centres of expertise.

REGIONAL POLICIES AND GUIDELINES

1. Translate regional policies and guidelines on water hyacinth into conventions and legislation that classify water hyacinth as a noxious, invasive weed to be controlled throughout the region.

2. Develop guidelines and policies to improve the response of national riparian programs to the water-hyacinth problem.

Plenary discussion on working-group presentations

This and following discussions had a free format: participants were motivated to raise important but unresolved issues and questions. Thus, several of the comments and questions remained unanswered. (Appendix 2 contains summaries of the working-group reports.)

COMMENT — Group 1 made reference to the ban on the use of herbicides to control water hyacinth in Egypt. I suppose that there should not be confusion in terms of this being specific to this weed. Egypt has banned virtually all forms of pesticides. The second point to make is that environmental-impact studies on herbicides in aquatic systems are very expensive.

There have been, however, very many studies on this, and a lot of information is already available. Available resources should therefore be used gainfully, rather than in reinventing the wheel.

COMMENT — On research, group 1 limited itself to assessing the impact of chemical control in aquatic ecosystems, as opposed to assessing results of control methods in general. This does not appear to be a balanced approach.

RESPONSE — The text was revised, and we also suggested impact studies on biological control. Emphasis still remains, however, on chemical control, to satisfy the environmental lobby.

COMMENT — Studies on the impact of water hyacinth are important for expected results and for advocacy. It is important to systematically look at social (health, employment),

economic, as well as environmental impacts. This information can be disseminated by an information clearinghouse.

QUESTION — Could group 1 consider, under research, the possibility of investigating other factors responsible for the propagation of water hyacinth, say, genetic factors?

RESPONSE 1 — Much work has already been done on the vegetative reproduction of water hyacinth, and for this reason further research in this area would not be the best way to allocate resources. No research has, however, been done on the dynamics of the water-hyacinth seeds and seed bank.

RESPONSE 2 — Water-hyacinth seeds remain viable for over 15 years, and each generation of flowering and seed-producing plants adds another 15 years to the weed problem. In the semi-arid areas, reservoirs and waterways dry up and water hyacinth disappears, but reinfestation occurs from germinating seeds at the onset of rains.

In crop plants, male sterility is widely used for hybrid-seed production. Applied to water hyacinth, there is a possibility of using sterile-male techniques to reduce this form of reinfestation. I do not propose this to appear on the priority research agenda, but I am only floating an idea.

RESPONSE 3 — There seem to be a lot of research results available already. The next step should be to examine these results, consolidate them, and disseminate them to people who need them.

The "people" factor should be the principal focus. For instance, potential impacts of water hyacinth on health, employment, migration, development of opportunities for youth, and so on should be focused on, rather than just the biophysical part of the problem.

COMMENT — Decision-makers are often faced with less clear considerations of whether, in the context of water-hyacinth control, we should aim at management or eradication. This can be a difficult decision in cases where real economic uses are found for water hyacinth.

COMMENT — From all the presentations, it is obvious that the question of how to ensure prompt decisions for effective control of water hyacinth has not yet been addressed.

QUESTION — I would like to know what group 2 meant by providing "better forums." What kind of mechanism did they have in mind?

RESPONSE 1 — The suggestion is to create forums for affected communities and an "agency," institution, or organization directly involved in combating water hyacinth, to enable the flow or exchange of information and ideas.

RESPONSE 2 — Such a forum needs to be created by government agencies concerned with water hyacinth, as a medium for communities or their representatives to voice their opinions. Such forums can also enable the communities to exert pressure on decision-makers and solve the problem of indecisiveness in handling water-hyacinth problems. Furthermore, such forums would enable representatives of communities affected by the weed to have more say in decisions on what is to be done to effectively combat it.

General plenary discussion

QUESTION — One of the working groups proposed the adoption of a Water Hyacinth Convention for Africa and the Middle East so that there are continental standards in place on the control of the weed. Can we please discuss this fully?

QUESTION — There are many conventions that could cater to the problem, for example, the Convention on Biological Diversity [CBD]. Have these been utilized fully?

RESPONSE 1 — The problem of water hyacinth fits well into the spectrum of the CBD. The CBD is establishing a clearinghouse mechanism, and the weed could be incorporated into this. If the water-hyacinth problem is accepted under the CBD, funding of efforts could be solicited from the GEF linked to the CBD.

RESPONSE 2 — The idea of a convention sounds very plausible but requires goodwill from governments at senior level for it to be implemented successfully. We may require a different forum, with a different level of representation, to effectively make a convention binding.

RESPONSE 3 — A convention requires political goodwill. This does not even exist at the national level. All working groups pointed to the problem of a lack of decisiveness at the political level. The problem is that politicians are not always open to logical argument. More often than not, they are swayed by vested interests, and therefore there is a need to create public pressure to force them to act.

In order to do that, information has to be produced in accessible formats for all sectors of society (two of the groups raised this as something the Water Hyacinth Information Clearinghouse could assist in producing).

COMMENT — Intergovernmental agreements, particularly between those who share water-hyacinth-infested water bodies, are key to overcoming institutional indecision and delays in implementing control strategies. When most efficient producers of biological-control agents are able to supply needy stakeholders without regard to national boundaries or ministerial-oversight regulations, we will really start combating water hyacinth.

COMMENT — There is a need to identify effective subregional and continental coordinating mechanisms to ensure implementation of recommended control measures at national, regional, and continental levels so that the constraint of "lack of effective mechanisms and the problem of indecisiveness" can be urgently addressed.

There is also a need for a clear definition of the "stakeholder groups" so that control mechanisms can be designed to target them.

COMMENT — A clearinghouse is a realistic possibility that could be implemented over the short term. It would be preferable to begin with the clearinghouse as a source of information, expertise, and consultancy services. Later, it could help push for a convention or for the development of international agreements involving water hyacinth. We need to address questions on what can be done immediately and where the clearinghouse should be housed initially.

COMMENT — The information clearinghouse should initially be housed in IDRC. It should have information dissemination among its principal mandates. It should ensure that information gets to policymakers and should also have a mechanism to obtain feedback from them. It should comprise a manager, a socioeconomist, and an information expert.

COMMENT — A clearinghouse should consist of a secretariat (at least one person equipped with good electronic-communication facilities) and be located in a suitable scientific establishment in Africa. The clearinghouse should support the IOBC Global Working Group on water hyacinth. It should make unpublished data on water hyacinth widely available. The secretariat should also disseminate information to interested parties at all levels, from affected communities, to researchers, to top-level politicians.

COMMENT — Setting up an information clearinghouse will be a useful initial step, which should be implemented immediately. Through this clearinghouse, information related to water hyacinth should be disseminated to those who need to use it in planning and executing control. It should also facilitate the interaction of experts in regional centres (such as research institutes, universities, and affected communities), authorities of concerned organizations (such as those involved in hydroelectricity schemes and irrigation), and donors interested in water hyacinth.

QUESTION — One of the working groups referred to the use of existing structures of communication and regional initiatives to improve response to water hyacinth. I am aware that there were attempts to do this in ECOWAS. Could our West African colleagues please comment on lessons to be drawn from the initiative?

RESPONSE — The ECOWAS Floating Weeds Project was initiated by a Netherlands-based organization called Euroconsult, and it formulated six different projects. These projects have been costed, and funding is being sought. The only thing remaining is to solicit the full commitment of ECOWAS governments and to have the governments provide bilateral funds.

COMMENT — There has been talk during the workshop about integrated control of water hyacinth and also about its utilization. To me it sounds like some methods of control and control versus utilization are potential areas of conflicting interests.

RESPONSE — The negative aspects of water hyacinth far outweigh the positive effects. No matter which control method is used, there will still be enough left for those who want to utilize the plant. Could all people who are experts on herbicides please make available references on impact-assessment studies?

QUESTION — A professor of mine was once on a committee that sought to reregister DDT in the early 1970s. He would, on occasion, consume DDT in public to demonstrate its "safety." Does Monsanto plan any similar demonstrations with glyphosate for the various national ministries concerned about chemical control of water hyacinth to accelerate approval of the herbicide within control projects?

RESPONSE — Animals, fish, and other nonplant organisms cannot metabolize glyphosate, and any intake will be excreted "unprocessed."

QUESTION — I would like to begin with a comment. As nature is manipulated more, there exist chances of invasion by other exotic invasive-weed species with consequences similar to or more serious than those of water hyacinth. Thought should be given to initiatives to establish long-term frameworks using lessons from awareness and knowledge of the water-hyacinth problem.

Second, mention has been made of the scarcity of funding as a problem that has slowed the implementation of water-hyacinth control. Have affected countries used all available (but not automatic) sources of funding, such as GEF?

Finally, I would like to suggest that the problem of water hyacinth be tackled using means with the least time lags to achieve results, and all available resources should be dedicated to the cause.

RESPONSE — In some countries, for instance, Nigeria, budgeting is not the problem, but approval of the budget and eventual allocation and release of funds are. The country's National Committee on Environmental Protection has the mandate and government funding to address all ecological problems, including water hyacinth. It has been sent a proposal, with the hope that it can be accommodated in the 1998 budget and in the 1998–2000 rolling plan. We have also included a water-hyacinth proposal in our agency's budget for 1998. Our hope is that at least one of these institutions will consider supporting some work on water-hyacinth control. If they do not, what do we do?

QUESTION — Water-hyacinth infestations have both environmental and socioeconomic impacts. In solving infestations, we are actually intending to alleviate these impacts. With this in mind, should we emphasize assessment of control efforts when implementing water-hyacinth programs or assessing these impacts?

RESPONSE — We should not look at socioeconomic research for the sake of it, but for it to justify further chances for the success of control programs. As an example, quantifying the negative impact of the weed and raising awareness can stimulate awareness among policymakers of the urgency of the need to take action.

COMMENT — To improve the response to water hyacinth, I would like to suggest intensification of training in biological control, mass rearing, and evaluation of natural enemies. A call for quarantine facilities may delay the implementation of biological control. I have learnt from three people from three different countries that they imported water-hyacinth natural enemies and kept them in quarantine for 2–3 years to conduct host-specificity tests. This was despite the fact that they were already certified agents of water hyacinth in other countries and in some cases had already been released in neighbouring countries.

RESPONSE — To release new biological-control agents, we will need to take the following steps:

- Follow the FAO guidelines and protocols in place;
- Share expensive quarantine facilities, which will expedite the evaluation and clearing of new biological-control agents; and
- Have the quarantine facility and scientists do the necessary host-specificity tests for other countries and save the time and duplication of efforts.

COMMENT — Short-term research activities should include

- Formulation of policy guidelines on water-hyacinth control;
- Development of a database to include water-hyacinth utilization; and
- Promotion of an early-warning system — I suggest production and distribution of pamphlets, booklets, posters, as an immediate awareness action — this can be done in the short term and can be identified with this workshop.

COMMENT — Public-awareness campaigns must start immediately, using print, electronic, and mass media. The efforts should concentrate on sectors of the local communities likely to get into contact with water bodies, especially women and children, as well as fishers. One may also put into the package a reward for spotting the presence of the weed.

COMMENT — Early-warning systems can make use of rural communities through public education of school children on water hyacinth. Information brochures, pamphlets, and leaflets on the weed should also be disseminated as widely as possible.

COMMENT — New Zealand has been dealing with its water-hyacinth invasion by spot eradication, based on community-participation and -awareness programs.

Plenary discussion on the Water Hyacinth Information Clearinghouse

COMMENT — The need to establish a clearinghouse has already been endorsed by the workshop. What remains is the definition of its mandate, functions, and activities. This can be worked out by a special working group.

COMMENT — I propose the establishment of a working group of about five to eight people to draft proposals for the Water Hyacinth Information Clearinghouse to include evaluation of government strategy and policy for dealing with the weed and structures for coordinating control efforts. Emphasis should also be put on harmonization and standardization of recommendations for biological control, herbicide use, and physical methods. The clearinghouse should also facilitate international cooperation.

COMMENT — I would like to suggest that the regional consultants who are already working with IDRC on the current project form the basis of a working group for the clearinghouse.

COMMENT — The current consulting group needs to diversify to combine experts in biological control with experts already managing operational programs using other alternatives.

COMMENT — I would like to commend the consultant group that has done the research on the problem of water hyacinth in Africa, as they have made this workshop a success. I would, however, like this forum to consider the eastern African region as having a special, much larger problem with the weed than any other region in Africa. I suggest that East Africa be represented in the proposed working group.

COMMENT — The steering committee will have to be willing to invest time to develop a document to be used in soliciting financial support from other donors.

COMMENT — The draft document to be produced by the working group should be circulated by e-mail among participants of this workshop for comments. These comments must be sent back to IDRC within 3 weeks. If no comments are received, then we should assume the recipients are satisfied with the draft.

COMMENT — I would like to suggest that IDRC host the secretariat for the proposed Water Hyacinth Information Clearinghouse, but it should be guided by African advisory boards or committees. Such groups should come out of this meeting.

COMMENT — I would like to suggest that partners to support and collaborate with IDRC on the Water Hyacinth Information Clearinghouse include FAO, CABI, and IOBC. The reasons for the suggestion are that

- They all have direct interest, experience, and activities on water hyacinth in Africa;
- They are not likely to favour any country and would therefore operate across the continent without bias; and
- They can assist in soliciting funding and would be prepared to take over the entire responsibility eventually.

COMMENT — IOBC has a significant role to play in the clearinghouse. The organization has decided to start a water-hyacinth working group and to edit and publish the proceedings emanating from the working group (IOBC). IOBC will also contribute to the water-hyacinth newsletter. Both these activities will depend on donor contributions. It is agreed that IOBC can link up with the initiatives taken by IDRC and develop a fruitful partnership.

It is further suggested that the President of IOBC (Afro-Tropical Region) meet with IDRC to discuss a possible partnership.

COMMENT — UNEP should be a major partner with IDRC in the clearinghouse, as it is also a major stakeholder in the environmental concerns of water-hyacinth infestations. Others should include FAO, OAU, SADC, ECOWAS, IITA, ICIPE, CABI, PPRI, and IOBC.

COMMENT — In structuring the information clearinghouse, we should look beyond the listed bodies or organs for partnership and also include international institutes. When we at IITA implemented the biological control of water hyacinth, we collaborated with such bodies. The partnership would take advantage of already-existing communication facilities.

COMMENT — The mandate of the clearinghouse should include commissioning of studies in gap areas, especially at the community level. Partnership of the clearinghouse should also include other donors providing funding.

Plenary discussion on recommendations for actions and research

QUESTION — Issues listed under research give an impression of the outcomes it will address. They do not include specific constraints to address to improve the manner in which, say, current policies are derived — how control efforts can be harmonized. Could we therefore be more explicit and identify specific constraints?

COMMENT — A follow-up to this question is that we should identify short-term research objectives that can be achieved immediately and those that may, or will, yield tangible benefits in the medium term to the countries suffering infestations.

RESPONSE 1 — Short-term research activities should emphasize obtaining the answers needed to enable national organizations to choose from among sufficiently documented and well-researched options in implementing control measures.

RESPONSE 2 — I see any immediate type of action not in research terms, but rather in terms of action on water-hyacinth control. The efforts should not just focus on biological control, but also include physical, mechanical, or herbicide treatment. The costs of the control methods themselves should be assessed, and so should their environmental impact and socioeconomic costs.

RESPONSE 3 — In prioritizing research, we need to distinguish between the use of impacted water resources, that is, multipurpose (such as rivers and lakes) versus single-purpose (such as irrigation canals and watering impoundments).

The need for research on water hyacinth, hence its priorities, will vary from situation to situation. For instance, in the multipurpose resource use, research on the environmental and socioeconomic impacts will be crucial, whereas in the single-purpose resources, the most critical will be the assessment of the economic cost of the weed and of its control.

Identification of the causes of water-hyacinth proliferation should be a medium- to long-term objective.

COMMENT — I would like to comment on policy analysis. Let us compile all country decisions and positions that have been taken on water hyacinth and the basis for the decisions. This should be distributed as widely as possible.

On integrated management of water hyacinth, we talk of integration of more than one option. We must generate data to be able to clearly demonstrate the antagonisms and synergisms of the various options available. Furthermore, if there is talk of biological control's not being effective, we must develop and identify a threshold level of water-hyacinth reduction over a specific period. This should be used to judge the performance of the biological-control agents. We must have a level of infestation at which we can say these agents have been effective or above which they have not been effective. Alongside this, we must also have a level of water-hyacinth infestation we could call tolerable; and above this level, control efforts should be implemented.

We should also develop a catalogue of each infested water body, its location, and what it is used for.

COMMENT — I wish to comment on the statement in this week's issue of an East African newspaper, which reported that water hyacinth increased fish catches. This sort of information is incomplete, as it does not indicate what types of species showed increased catches. It also does not indicate whether such species were desirable for local consumption and for marketing.

COMMENT — The role of physical control was discussed by one of the working groups. The feeling is that sometimes, and in some situations, it is the prominent short-term approach to relieving water-hyacinth congestion and the problems it immediately causes for communities. The feeling, however, is that it is costly but that in some situations there is no other immediate option available.

COMMENT — I wish to recommend a study on the most cost-effective method of physical removal of water hyacinth in the context of local communities. I would also like to suggest an environmental-impact assessment of mechanical harvesting, incorporating the economic advantages of this method.

COMMENT — On the issue of research on mechanical control of water hyacinth, I would like to suggest the following topic: What is the impact of dumping mechanically or manually removed water-hyacinth plants?

COMMENT — The physical method for preventing immediate water-hyacinth reinfestation is to place strong cables and appropriate buoys (sufficient to keep the cables up and in place). The cables should be placed across the river where the infestations originate. It should also be noted that the cables need to be managed and should not be left unattended, as the weed can build up behind them, causing breakage with its weight. Water-hyacinth plants behind the cables need to be sprayed with herbicide.

COMMENT — Containment of water hyacinth can be accomplished in the short term by involving communities in seasonal manual removal.

COMMENT — There appears to be immense literature on the utilization of water hyacinth as a fertilizer or mulching material; an animal feed; and a source of energy (from briquettes and biogas). Utilization of the weed is, however, not discussed as a control strategy. May I call the floor to expand on this issue, as it is not mentioned on the board?

RESPONSE 1 — The cost–benefit analysis, where the policy is for control, shows that in the final analysis, it is better to use materials other than water hyacinth for most of these alternatives. After all, water hyacinth contains more than 90% water.

RESPONSE 2 — Water hyacinth contains about 85–90% water. No one has found an economically profitable use for the weed. LVEMP in Kenya has received proposals ranging from 1 million to 80 million USD on utilization of water hyacinth, but none appears feasible.

RESPONSE 3 — In Nigeria, almost all types of research have been done on the economic uses of water hyacinth, including paper-making, board-making, biogas production, animal-feed production, and manure. What we still have not done is a cost–benefit analysis, which I believe is a must when discussing economic uses of the weed. At least, this is true for all ECOWAS countries. I would not be surprised if the same applies to other areas, including Egypt and Sudan.

RESPONSE 4 — The water-hyacinth menace could be considered a disease plaguing our water bodies. Whereas in wider logical circumstances one would need to look at the economics of solving a problem, it would make no sense questioning the cost of treating oneself — as with a disease.

Utilization should be given a chance. It could just stimulate control of the weed. No matter how little one makes out of it, provided this contributes to control, it cannot be ignored and should therefore not be ignored. Talk of utilization should not, however, be *in lieu* of control.

Chapter 11

REFLECTIONS AND ACKNOWLEDGMENTS

Luis Navarro

Friends and colleagues, I want to express my personal gratitude to you for the knowledge, experience, and goodwill you contributed during this 3-day workshop. As one of the workshop organizers and a member of the facilitating group, I am pleased with what I think we have achieved. I will not pretend to have captured everything you have provided us with thus far, so I am confident that we have more than I can register in my mind. We will make certain that your contributions are given more faithful account and credit in the proceedings of this workshop.

My special thanks go to our guest speaker, Dr Orach-Meza, for his informative address and his active participation in the plenaries and the working groups. Special thanks go to the working-group chairpersons, Dr Zimmermann, Dr Findlay, and Dr Woomer, for their stamina and ability to lead productive discussion. I know they were working until late to provide us with their respective group reports. Special thanks also to our team of consultants, who have been struggling to know more about the extent of the water-hyacinth problem across the region and report on it to us. They have assessed the social consequences of the weed in communities across AME and how it affects their economies and environments. Special tribute is due to Prof. Fayad, Dr Bashir, Dr Cilliers, Mr Diop, and Dr Phiri. I also thank your partners, Prof. Khattab and Mr Dieng, who could not be with us here. We appreciate your contributions.

We brought here a representative group of the cream among experts on water hyacinth to search for solutions to the weed problems in AME. The discussions have led us to the conclusion that to be more effective, we must recruit more members (especially from the social and economic sciences), interact more with decision-makers, and start dialogue with the private sector and the affected communities. We already know a lot about how to control water hyacinth, and a lot could be done immediately to deal with the problem. However, many difficulties in implementation remain, most of which fall under the ambit of other disciplines

and experts. We need, therefore, to open our own minds, with optimism, to the challenge of expanding our association.

A lot is required to assess the impacts of water hyacinth on communities, their economies, and the environment. Such information would help decision-makers and donors see the urgency of the need to address this problem. Sadly, such information is not readily available. Even our consultants were unable to obtain very much of this type of information, although they attempted to do so.

Given the composition of our group, the recommendations from this workshop will appear somewhat biased, but they provide useful baseline information.

On research, the suggestions that emerged from the working groups indicate a desire to go deeper and wider into the technical analysis of water hyacinth and its interactions with the environment. In terms of control approaches, the working groups clearly favoured making further investigation of the role of biological control and the ways of making such control more effective and efficient, despite acknowledging that this approach alone may not immediately solve the problem in crisis situations, such as that in Lake Victoria. This approach may even delay immediate action and the emergence of integrated approaches, which are also required immediately.

On organization, the working groups acknowledged the existence of the relevant bodies in various countries but provided suggestions for an ideal organization to deal more effectively with water hyacinth in Africa. These suggestions also reflect the working groups' recognition of the need for better coordination, collaboration, and leadership of the existing bodies and people with expertise.

On mobilization, the working groups acknowledged that the people who suffer directly from water hyacinth do what they can to cope with it but added that they certainly need help to improve the effectiveness of their efforts. Most of these people can hardly even voice their concerns and are even less able to pay for solutions. Those who appear to have the knowledge and capability to help — for example, scientists, technicians, and private companies — seem unable to do so, as a result of a lack of resources, organization, and leadership. Those who should be the prime movers and leaders, including policymakers, do not seem to be impressed by the issues early enough to see the dangers of delaying action. Those who suffer only indirectly may not even be aware of this, and thus their concern and participation in the formal process of controlling the weed may be minimal or even nil.

We were glad to learn of the consensus that timely access to proper information for all interested parties is a helpful factor in control and that a good deal of such information already exists, although it is not flowing well, if at all. This understanding reinforces our quest for a Water Hyacinth Information Clearinghouse to facilitate exchange and flow of information among key players, which could make an important contribution to water-hyacinth research. We will certainly follow on the strength of your advice and endorsement.

Finally, I want to acknowledge the encouragement and support from our Regional Director, Dr Eva Rathgeber, during the water-hyacinth project and this workshop. Further support and encouragement came from my PLaW teammates, Dr Eglal Rached from our Cairo office and Mr Wardie Leppan from our Johannesburg office. I am grateful to Amina Kasinga, our facilitator, for her help and patience and her ability to accommodate the unconventional format we gave her for this workshop. Dr George Phiri, as the leading consultant, also helped in most of the planning and logistical work. Mrs. Florence Waiyaki, Hilda Kagure, John Mwambingu, and others ran the secretariat superbly.

Once again, thanks to all of you for coming and for sharing your experiences and expertise with us.

I wish you all a safe trip back home.

Chapter 12

WORKSHOP CLOSING REMARKS

Eva M. Rathgeber

I am pleased to say a few words to close what has been a most interesting and successful workshop. Over the past few days, we have focused our attention on the scourge of water hyacinth plaguing freshwater bodies throughout Africa. We have heard experts from many different countries talking about the appalling extent of the problem and about the means that could be, and should be, employed to rid Africa of this noxious weed.

In this part of Africa, water hyacinth was first reported in Tanzania in 1960 and in Ethiopia in 1965, but Zimbabwe has had the problem since 1934 and South Africa and Egypt had it even earlier. As we learned during the workshop, water-hyacinth infestation currently covers all countries in eastern and southern Africa, with the exception of Botswana, Lesotho, and Swaziland. Thus, it is clear that water hyacinth is not a new problem, but it is becoming more serious with each passing day.

The negative environmental effects of the weed have already been understood for some time, but the effects on the economies of lakeside communities that depend on fishing, water transport, tourism, or other water-related activities for their livelihoods is starting to become very clear in Kenya, Tanzania, and Uganda. Moreover, the negative health effects are also starting to be seen, for example, with a proliferation of mosquitoes, leading to an increased incidence of malaria. In countries already struggling to achieve development goals, water-hyacinth infestation has set up yet another serious obstacle.

This workshop has confirmed that scientists in Africa and elsewhere already know quite a lot about water hyacinth and the well-established methods to control or even eradicate it. These methods range from mechanical removal, to chemical and biological control, to combinations of these.

But if we already know how to control or eradicate water hyacinth, why has it become an ever greater scourge in Africa? Is this due to a lack of political

will to decisively deal with the problem? Is it due to a lack of financial resources to take action? Is it due to a lack of coordinated information on how to tackle water hyacinth? No doubt it is due to a combination of all of these and many other factors, and of course it has been beyond the scope of this workshop to try to identify all the reasons or, indeed, to attempt to find solutions.

However, what has become obvious during our discussions over the past 3 days is that there is an information gap. We need to more systematically collect, organize, and disseminate information and share it with all the various actors concerned with water hyacinth. These include policy-makers, scientists, researchers, donors, and, most importantly, the affected communities themselves.

This workshop has provided an opportunity for researchers, policymakers, entrepreneurs, and others concerned with the water-hyacinth infestation of Africa's freshwater bodies to share ideas and insights on how to deal with the problem. You have identified the information gap as an issue of critical importance, and one of the most important ideas to come out of the workshop is the recommendation to establish a Water Hyacinth Information Clearinghouse to coordinate research and information.

This clearinghouse is envisaged as becoming an information centre for anyone wanting to know about current practices in dealing with water hyacinth in Africa or elsewhere in the world. The clearinghouse would also commission a few studies on issues not as yet well understood, such as the scope of the economic impacts of water hyacinth on lakeside communities and regional economies.

It is anticipated that the clearinghouse would use electronic means to search databases worldwide for relevant and up-to-date knowledge and information. During the first year, IDRC would house the clearinghouse at its offices in Nairobi. However, in the longer term, we expect more donors will support the initiative and it will be housed in a regional organization.

I would like to end by thanking you for having attended the workshop and for having given all of us the benefit of your experiences and insights.

Appendix 1

SURVEY QUESTIONNAIRE

INSTITUTIONS AND ORGANIZATIONS INVOLVED IN THE WATER-HYACINTH PROBLEM IN AME[1]

Location (Region/Country/Town/Agency) _____

Date _____ Name of consultant _____

Name/Title/Contact of interviewee _____

Survey questionnaire

Survey objective	Field questions/ issues and responses	Consultant's remarks
1. Trends of WH in AME [a]	Is WH perceived as a problem? Yes/No	
	What institutions and communities are affected by or concerned about WH in the area?	
	What is the history of WH in the area?	
	Are the problems associated with water hyacinth locally a. Social? Specify type b. Economic? Specify type c. Environmental? Specify type	
	Were/are there any difficulties in responding to a growing WH problem in the area? Yes/No If yes, what are the reasons?	

(continued)

[1] Condensed version, for presentation.

Survey questionnaire continued.

Survey objective	Field questions/issues and responses	Consultant's remarks
	Is there a coordinated institutional framework handling the WH problem? Yes/No If yes, give description of Agent: Objective: Achievement: Future plans: Source of funding:	
	How many scientists are dedicated to the control of WH?	
	How many technical-support staff do you have in the WH-control program?	
	Financial scale of the project:	
	Date of project commencement and duration of the project:	
	What is the general trend of WH problem? Increase/Decrease/No change/No knowledge	
	How many other institutions or organizations work on WH in the country? Please list them Which of the above institutions do you interact or collaborate with?	
	What are the suggestions for a priority WH-management research agenda?	
	What suggestions do you have to improve the management of WH in your country?	

(continued)

Survey questionnaire continued.

Survey objective	Field questions/issues and responses	Consultant's remarks
2. Communication and information-exchange mechanisms on WH problems	Does the agent have access to information on WH? a. On problems in general? Yes/No b. On problems elsewhere? Yes/No c. On control methods? Yes/No	
	What are your sources of information on WH?	
	Do you have access to a. Modern methods of communication? Yes/No If yes, please specify which ones? b. Electronic sources of WH information? Yes/No If yes, please specify which ones? c. Modern methods of sourcing information on WH? Yes/No If yes, please specify which ones?	
	Any suggestions to improve the exchange of information within the country? Yes/No If yes, describe them	
	What suggestions do you have for improving interregional communication?	
3. Potential participants in a consultative workshop	Name: Post held: Contact: Academic qualifications: Current research area of interest:	

(continued)

Survey questionnaire concluded.

Survey objective	Field questions/issues and responses	Consultant's remarks
	Name: Post held: Contact: Academic qualifications: Current research area of interest:	
4. Do you have any other remarks on improving the WH-management capability in the region?		

[a] AME, Africa and the Middle East; WH, water hyacinth.

Appendix 2

REPORTS FROM WORKING GROUPS

Group 1: On short- and long-term-priority research agenda

Helmuth Zimmermann, Chair

Short- and long-term-priority research agenda

1. Accelerate the testing and release of additional new natural enemies of water hyacinth in Africa, including insects and pathogens (such as a rust, a fungus), the aquatic grasshopper *Cornops* spp., and the fly *Trypticus* spp. (long term).

2. Conduct research to improve integrated control methods, including studies on the compatibility of herbicidal and biological control, as well as uses for water hyacinth (short term).

3. Investigate the root causes of water-hyacinth infestations, which may include pollution, reinfestation through dispersal, and regrowth from seed banks (long term).

4. Investigate the possibility of antagonistic effects of multiple releases of biological-control agents before additional agents are released (long term).

5. Assess the impacts of chemical control on unique and sensitive aquatic ecosystems in Africa (long term) (considerable general information already exists).

6. Evaluate appropriate control strategies that specifically involve the affected communities, including water users and fishers (communities need to be brought into the program and to fully participate in it, using their own resources) (short term).

7. Determine realistic and acceptable threshold levels of residue water hyacinth, together with equilibria obtained from biological control in various systems (short term).

8. Study the seed-bank dynamics of water hyacinth (short term).

9. Evaluate biological, chemical, and mechanical control in diverse systems, such as rivers, dams, wetlands, lakes, and high-elevation areas (short term).

10. Develop bioherbicides (long term).

11. Intensify studies of the socioeconomic impacts of water hyacinth on issues such as health and employment (short and long term).

12. Develop principles of integrated management planning, including analyses of costs and benefits (short term).

Implementation strategies

1. Give access to all relevant information on water hyacinth and its management and control to communities at all levels, including awareness campaigns, training, and education.

2. Identify one entity responsible for decisions on water hyacinth and its management, backed by expertise within a supportive line function. It should preferably have legal support through an Act of parliament.

3. Resolve conflicts regarding

   - Available control measures (for example, chemical versus biological control);

   - Number of decision-makers (to avoid having poorly structured line functions and uninformed advisers); and

   - The issue of use versus control (where some stakeholders still regard water hyacinth as beneficial and therefore refuse to accept the need to control it).

4. Use existing and functional regional substructures, such as Tecconile, SADC, and ECOWAS, for handling and controlling the water-hyacinth problem. Most of these substructures have political backing, and their actions could therefore carry weight. Consider involving OAU at the continental level to deal with water hyacinth.

5. Identify the true stakeholders affected by water hyacinth and their contribution to the decision-making process related to the weed and its management. These stakeholders should then become part of further decision-making processes.

6. Establish structures specifically to deal with water hyacinth. These structures should represent all stakeholders and provide them with financial support to facilitate their work.

7. Make use of national and regional policies or guidelines on aquatic weeds and their control to deal effectively with water hyacinth. In addition, make use of conventions (for example, the Nile River Convention) and bilateral or multilateral agreements between countries to address the water-hyacinth problem. Conventions and agreements may also harmonize national policies on management of the weed.

8. Support legislation to deal specifically with issues pertaining to water hyacinth. Such legislation may address problems related to cultivation, sale, and transportation of the weed or be designed to prevent soil erosion and water pollution.

The Water Hyacinth Information Clearinghouse

1. Use existing information and networks to foster cooperation among countries and harmonize national measures dealing with water-hyacinth issues.

2. Design the clearinghouse to collate all published information on water hyacinth on a global level and to disseminate pertinent information to stakeholders in AME, including current information on ongoing projects, recent successes and failures, and new strategies and breakthroughs.

3. Ensure that the clearinghouse maintains an up-to-date database on who is doing what and where in the region and in other continents.

4. Have the clearinghouse assist in organizing water-hyacinth workshops (at the continental level) and seminars (at the regional and subregional levels).

5. Ensure that the clearinghouse information service is available to all, including those with different levels of understanding. The publication of leaflets, posters, booklets, and specific literature on water hyacinth should be part of an awareness campaign.

6. Investigate possible linkages between the clearinghouse and the International Union for the Conservation of Nature and Natural Resources, FAO, OAU, United Nations conventions, and other relevant institutions and organizations within AME. Some of these international institutions are already dealing with water-hyacinth issues and are thus able to provide functional support for activities of the clearinghouse.

7. Investigate possible sources of sustainable funding for future activities of the clearinghouse beyond the period of IDRC's initial involvement.

Group 2: On identification of gaps and opportunities for action

Paul Woomer, Chair

Guidelines for operational strategies

1. Make the best use of secondary sources of information. Focus primary investigations on site-specific water-hyacinth problems in situations for which proven methods of control are in use.

2. Provide assistance to oversight agencies, rather than evolving a complex research agenda.

3. Base control strategies on a risk–benefit analysis (preferably in monetary units).

4. Take advantage of remote-sensing information to monitor water hyacinth.

5. Develop general-control and early-warning systems for different problem types (confined waters, large open water bodies, river catchments, smaller waterways, etc.).

Information gaps within and between research organizations and between partners in areas with water-hyacinth infestations

1. Establish an action-oriented network, the Water Hyacinth Information Clearinghouse.

2. Ensure the Water Hyacinth Information Clearinghouse has access to world-wide information and provides water-hyacinth researchers with guidance concerning opportunities for funding and a database on water-hyacinth control.

3. Mobilize local communities (the ultimate clients of water-hyacinth programs), not simply to supply labour for ineffective manual clearance, but to ensure that the lessons learned by one research group or community do not have to be "rediscovered" by another without full appreciation of opportunities or consequences.

4. Ensure that water-hyacinth use is well-founded at the community level, that it is used on or near the site, and that bulky products (for example, composts, feed supplements) are never transported to noninfested areas.

5. Treat the water-hyacinth invasion of eutrophic and polluted waters as a symptom of land and water mismanagement, rather than as an independent issue, and include it in a broader program for environmental and development awareness.

The delay between problem recognition and control response

1. Obtain full recognition of the water-hyacinth problem through political channels.

2. Convince donors that the ability to minimize the biological invasion of water hyacinth in AME can be enhanced by strengthening technical and community-development expertise, as well as strengthening policy and institutional determination to use existing capabilities.

3. Enact straightforward and flexible legislation and enforce it reasonably.

4. Provide better forums for local communities and experts in water-hyacinth control to express their concerns and exchange experiences.

Contribution of African scientists to the technical and scientific knowledge of water-hyacinth control

1. Develop sterile water-hyacinth seed stocks in noncontinuous aquatic environments, and use locally obtained, natural control agents.

2. Improve information concerning the mechanisms of water-hyacinth invasion throughout Africa.

3. Establish new and innovative control or monitoring methods, and pioneer techniques for using water hyacinth.

Group 3: On implementation strategy

Jim Findlay, Chair

Establishing government policy

1. Appoint a single responsible authority (and project manager) for implementing government policy on water hyacinth at the country level.

2. Involve the highest levels of all affected ministries (Health, Water Affairs, Forestry, Agriculture, etc.) in developing and implementing government policy on water hyacinth.

3. Draw up, support, and implement legislation on water hyacinth.

4. Complement the national policy on water-hyacinth control with control efforts at the national level.

5. Build in flexibility to facilitate regional cooperation and implementation.

Finance

1. Give water-hyacinth control its own budget and financial allocation.

2. Include governments, donors, and nongovernmental organizations among sources of funds.

International cooperation

1. Involve the highest government level in controlling water hyacinth in internationally shared water bodies, such as Lake Victoria and the rivers Niger, Nile, and Zambezi.

2. Use existing organizations and regional authorities, such as SADC, and create new ones.

Water-hyacinth surveys, an essential component in control efforts

1. Identify the problem, its location, and the level of infestation.

2. Identify potential new infestations.

3. Plan continuous and regular monitoring.

4. Assess existing and potential problems, including socioeconomic problems associated with water hyacinth. Make these results available and use them to lobby for support for control efforts.

5. Identify, address, and monitor sources of water pollution.

6. Use available water-hyacinth expertise as much as possible.

Objectives

Immediate and short term

1. Appoint a committed water-hyacinth management team.

2. Prioritize areas of water-hyacinth infestation for immediate action.

3. Develop an action and operational plan to incorporate logistics and ongoing surveys.

4. Set up and make operational a rapid-response unit.

Medium term

5. Develop and make functional a biological-control unit (Who is to run it? Where is it to be? Where is the screening of new agents to be done?) and initiate agent multiplication and regular release.

6. Set up a herbicide-treatment unit.

7. Set up a unit for mechanical and manual (physical) control.

8. Conduct socioeconomic-impact studies.

9. Put in place a specialist training program in biological control.

Long term

10. Reduce water hyacinth to levels at which it no longer causes socio-economic problems.

11. Eradicate water hyacinth where possible, as a way of containment.

Resources for the Water Hyacinth Control Program

1. Identify the resources required and those available.

Implementation plan

Communication and Information Unit

1. Put in place an information officer or manager to develop strategies for dissemination of water-hyacinth information at interdepartmental, local community, and national (public-awareness) levels. The Communication and Information Unit should have access to all the available sources of water-hyacinth information. As much as possible, it should use established routes of communication, but it may have to create new ones.

Biological Control Unit

2. Use, to the full extent possible, the available expertise in the Biological Control Unit. Give it responsibility for the following main activities:

   - Training;
   - Quarantine and screening and multiplication of agents;
   - Monitoring; and
   - Ongoing research.

Herbicides Control Unit

3. Use, to the full extent possible, the available expertise in the Herbicides Control Unit. Give it responsibility for the following main activities:

   - Equipment (for both air and land treatment);
   - Logistics; and
   - Environmental-impact assessment.

Physical Control (Mechanical/Manual) Unit

4. Give the Physical Control (Mechanical/Manual) Unit the following main activities:

   - Logistics; and
   - Choice of equipment and tools.

Community Involvement

5. Support for community involvement is essential. To involve the community, consider the following:

   - Training;
   - Availability of labour; and
   - Participation in monitoring and early-warning systems.

Appendix 3

List of Workshop Participants

Ms Lilian Adhiambo
Journalist
East African Standard
P.O. Box 30080
Nairobi, Kenya
Phone: 254-2-540280
Fax: 254-2-553939

Dr J.L. Aston
Project Leader
Global Crop Protection Federation
P.O. Box 30321
Nairobi, Kenya
Phone: 254-2-43404
Fax: 254-2-47279
E-mail: aston@formnet.com

Mr John Baraza
Executive Director
Spatial Information Systems
P.O. Box 51445
Nairobi, Kenya
Phone: 254-2-823917

Prof. Magzoub Omer Bashir
ICIPE Field Station
1213 Port Sudan
Sudan
Phone–fax: 249-11-29108
E-mail: yamagzoub@yahoo.com

Mrs Helen Kitaburaza Bugaari
Environmental Coordinator
Aquatics Unlimited
Nile International Conference Centre
Station 235, P.O. Box 7057
Kampala, Uganda
Phone: 256-41-250550
Fax: 256-41-250550
E-mail: aquatics@imul.com

Dr Carina Cilliers
Project Leader and Specialist Researcher
Aquatic Weeds
Agricultural Research Council, PPRI
Private Bag X134
Pretoria 0001, South Africa
Phone: 27-12-3293274
Fax: 27-12-3293278
E-mail: rietcjc@plant2.agric.za

Dr Steve Collins
Area Manager
East Central Africa
Monsanto
P.O. Box 47686
Nairobi, Kenya
Phone: 254-2-212756
Fax: 254-2-210341
E-mail: steve.c.collins@monsanto.com

Mr Kweku Amoako Atta deGraft-Johnson
National Project Coordinator
Integrated Control of Aquatic Weeds in Ghana
Environmental Protection Agency
P.O. Box M326
Accra, Ghana
Phone: + 021 664697
Fax: + 233 21 234084
E-mail: epainfo@ncs.com.gh

Dr J.S. De Wet
Department of Water Affairs
Private Bag 13193
Windhoek, Namibia
Phone: 264-61-2963021
Fax: 264-61-2963023
E-mail: wets@mawrd.gov.na

Mr Ousseynou Diop
Head
Control and Forecasting Division
Plant Protection Department
P.O. Box 72
Rufisque, Senegal
Phone: 221-340397
Fax: 221-344290

Dr Yahia Hussein Fayad
Plant Protection
PPRI
63 Ismael Kamel St, Helwan
Cairo, Egypt
Phone: 202 5554158 (home)
E-mail: yhfayad@excite.com

Mr Andrew Fernandes
Monsanto
P.O. Box 47686
Nairobi, Kenya
Phone: 254-2-212756
Fax: 254-2-210341
E-mail: ctrywide@iconnect.co.ke

Dr J.B.R. Findlay
Agricultural Resource Consultants
P.O. Box 3474
Parklands, Zizi, South Africa
Phone: 27-11-486-2254
Fax: 27-11-486-2274
E-mail: agrecon@pixie.co.za

Dr Chris Gakahu
National Programme Officer
Environment
UNDP–Nairobi
P.O. Box 30218
Nairobi, Kenya
Phone: 254-2-228776
Fax: 254-2-331897

Dr Waweru Gitonga
Research Scientist
Kenya Agricultural Research Institute
P.O. Box 30148
Nairobi, Kenya
Phone: 0154 32394
Fax: 0154 32090

Dr Garry Hill
Deputy Director
IIBC
Silwood Park, Buckhurst Rd
Ascot, Berks SL5 7TA, UK
Phone: 44-1344-872-999
Fax: 44-1344-875-007
E-mail: g.hill@cabi.org

Dr G.W. Howard
Programme Coordinator
Eastern Africa
East African Regional Office
IUCN
P.O. Box 68200
Nairobi, Kenya
Phone: 254-2-890605
Fax: 254-2-890615
E-mail: gwh@iucn.unm.org

Dr Amira Abdi El-Hamid Ibrahim
Biological Control Department
Agricultural Research Council
PPRI
Mohammed Fadel St (corner of Al Haram Ave)
Giza, Cairo, Egypt
Phone: 202 5686743

Mr R.W. Jones
Officer in Charge
Enseleni Nature Reserve
Natal Parks Board
P.O. Box 713
Richards Bay 3900, South Africa
Phone: 0351 923732
Fax: 0351 923732

Dr Richard Kagwamba
Natural Resource Specialist
World Bank
P.O. Box 30577
Nairobi, Kenya
Phone: 254-2-260300
Fax: 254-2-260384

Dr Warui Karanja
Department of Zoology
University of Nairobi
P.O. Box 30197
Nairobi, Kenya
Phone: 254-2-442014
Fax: 254-2-442316

Ms Amina Kasinga
Resident Consultant
Eureka Educational Training Consultants
P.O. Box 90097
Mombasa, Kenya
Phone: 254-11-314514
Fax: 254-11-221874

Mr Oketch Kendo
Journalist
East African Standard
P.O. Box 30080
Nairobi, Kenya
Phone: 254-2-543930
Fax: 254-2-553939

Dr Koffi Koffi Philibert
Technical Advisor
GEF/UNDP Aquatic Project
CIAPOL
BP V 153
Abidjan, Côte d'Ivoire
Phone: 225 376502
Fax: 225 376503

Dr George Krhoda
Environmental Advisor
Royal Netherlands Embassy
P.O. Box 41537
Nairobi, Kenya
Phone: 254-2-22711-4
Fax: 254-2-339155

Mr Wardie Leppan
Program Officer
Regional Office for South Africa
IDRC
P.O. Box 477
Wits 2050, South Africa
Phone: 27-11-403-3952
Fax: 27-11-403-1417
E-mail: wleppan@idrc.org.za

G.R. Lewin
Tiger Bay Fisheries
P.O. Box 114
Norton, Zimbabwe
Phone: 263-4-499675
Fax: 263-4-499675

Ms Susan Linnee
Associated Press
P.O. Box 47590
Nairobi, Kenya
Phone: 254-2-250168
Fax: 254-2-221449
E-mail: slinnee@ap.org

Dr Cecil Machena
Deputy Director
Research
National Parks and Wildlife Management
P.O. Box CY 140 Causeway
Harare, Zimbabwe
Phone: 263-4-792785
Fax: 263-4-724914

Dr A.M. Mailu
Deputy Director
Water Hyacinth Component Coordinator
Kenya Agricultural Research Institute
P.O. Box 57811
Nairobi, Kenya
Phone: 254-2-583301-20
Fax: 254-2-583294

Mr S.A. Mapila
Deputy Director
Fisheries Department
Ministry of Forestry, Fisheries and Environmental Affairs
P.O. Box 593
Lilongwe, Malawi
Phone: 265 743239
Fax: 265 721117

Dr Dennis McCarthy
Regional Economic Development Support Office
USAID
P.O. Box 30261
Nairobi, Kenya
Phone: 254-2-751613
Fax: 254-2-743204
E-mail: dmccarthy@usaid.gov

Mr Mina Iskander Mikhail
Chair, Aswan Earthquake Center
Chair, Aswan High Dam – Egypt
MPWWR
39 Alexander El Akbar St
Azarita, Egypt
Phone: 097 480441
Fax: 097 481453

Mr Thomas G. Moorhouse
Technical Coordinator
Aquatics Unlimited
Nile International Conference Centre
P.O. Box 7057, Kampala, Uganda
Phone: 256-41-250550
Fax: 256-41-257824
E-mail: aquatics@imul.com

Ms Hilda Munyua
Information Specialist
Regional Office for Africa
CAB International
P.O. Box 76520
Nairobi, Kenya
Phone: 254-2-747337
Fax: 254-2-747340
E-mail: hmunyua@cgnet.com

Mr Takehiro Nakamura
Programme Officer
Water Branch
UNEP
P.O. Box 30552
Nairobi, Kenya
Phone: 254-2-623886
Fax: 254-2-624249
E-mail: takehiro.nakamura@unep.org

Dr Luis Navarro
Senior Program Specialist
IDRC
P.O. Box 62084
Nairobi, Kenya
Phone: 254-2-713160
Fax: 254-2-711063
E-mail: lnavarro@idrc.or.ke

Dr Maurice Ndege
Africa Water Network
P.O. Box 10538
Nairobi, Kenya
Phone: 254-2-555579
Fax: 254-2-555513
E-mail: awn@elci.apc

Mr Friday J. Njaya
Principal Fisheries Officer
Fisheries Management
Fisheries Department
P.O. Box 47
Mangochi, Malawi
Phone: 265 584813
Fax: 265 721117

Dr Micheni Ntiba
Lake Victoria Fisheries Organization
Executive Secretary
P.O. Box 1625
Jinja, Uganda
Phone: 256-43-122071

Mr Dick Nyeko
National Coordinator
Water Hyacinth Control
Ministry of Agriculture, Animal Industry and Fisheries
P.O. Box 4, Entebbe, Uganda
Phone: 256-41-321430
E-mail: whc@imul.com

Mr Ajuonu Obinna
Release and Impact Assessment of Natural Enemies
Biological Control
IITA
Box 088P 0932 Cotonou, Benin
Phone: 229 350188
Fax: 229 350556

Prof. Joseph B. Ojiambo
Head
National Secretariat
LVEMP
P.O. Box 30126
Nairobi, Kenya
Phone: 254-2-218189
Fax: 254-2-243464

Mr Douglas Okwach
Features Writer
East African Standard
P.O. Box 30080
Nairobi, Kenya
Phone: 254-2-540280
Fax: 254-2-553939

Mr Francis M. Opar
Principal Research Officer
Kenya Industrial Research Development Institute
P.O. Box 30650
Nairobi, Kenya
Phone: 254-2-557762
Fax: 254-2-557769

Dr Faustino Orach-Meza
Head
National Secretariat
LVEMP
P.O. Box 19
Entebbe, Uganda
Phone: 256-41-20040
Fax: 256-41-20132

Dr George Phiri
Scientist on Water Hyacinth
CAB International
P.O. Box 76520
Nairobi, Kenya
Phone: 254-2-747329
Fax: 254-2-747347
E-mail: g.phiri@cgnet.com

Ms Mary L. Plummer
Fulbright Fellow 1997–98 on Water Hyacinth in Lake Victoria
Fulbright Foundation
P.O. Box 27, Post St
Mwanza, Tanzania
Phone: 255-28-500487
Fax: 255-28-500486
E-mail: kudrati@tan2.healthnet.org

Dr Eglal Rached
Chief Scientist
IDRC
P.O. Box 14 Orman
Giza, Cairo, Eygpt
Phone: 202 3367051
Fax: 202 336 7056
E-mail: erached@idrc.org.eg

Mr Dennis Rangi
Regional Representative
CAB International
P.O. Box 76520
Nairobi, Kenya
Phone: 254-2-747337
Fax: 254-2-747340
E-mail: d.rangi@cgnet.com

Dr Eva Rathgeber
Regional Director
IDRC
P.O. Box 62084
Nairobi, Kenya
Phone: 254-2-713160
Fax: 254-2-711063
E-mail: erathgeber@idrc.or.ke

Mr Sarwat Salem
Regional Controller
IDRC
PO Box 62084
Nairobi, Kenya
Phone: 254-2-713160
Fax: 254-2-711063

Dr Fami A. Titilola
Acting Director
Department of Biological Sciences
Directorate of Science
NASENI
9, Kofo Abayomi St, Victoria Island
Lagos, Nigeria
Phone: 614765
Fax: 614759

Dr Clesensio Tizikara
Assistant Director
Office of the Director General
National Agricultural Research Organisation
P.O. Box 295
Entebbe, Uganda
Phone: 256-41-320512
Fax: 256-41-321070
E-mail: naro@starcom.co.ug

Dr Timothy Twongo
Fisheries Research Institute
P.O. Box 343
Jinja, Uganda
Phone: 256-43-120484
Fax: 256-43-122050

Dr Paul Woomer
Visiting Lecturer
Department of Soil Science
University of Nairobi
P.O. Box 29053
Nairobi, Kenya
Phone: 254-2-520328
E-mail: biofix@arcc.or.ke

Mr Samir Ibrahim Yacoub
Undersecretary of State
MPWWR
Saad Zaghloul St
Fayoum, Eygpt
Phone: 084 343137
Fax: 084 343137

Mr Yoshiharu Yamada
Progamme Officer
Water and Environment
Japan International Cooperation Agency
P.O. Box 50572
Nairobi, Kenya
Phone: 254-2-724121
Fax: 254-2-724878

Mr Israel Zandonda
Senior Inspector
Water Pollution Control
Environmental Council of Zambia
P.O. Box 35131
Lusaka, Zambia
Phone: 260-1-254130
Fax: 260-1-254164
E-mail: necz@zamnet.zm

Dr Helmuth G. Zimmermann
Manager
Control of Alien Plant Invaders
PPRI
Private Bag X 134
Pretoria 0001, South Africa
Phone: 27-12-329-3276
Fax: 27-12-329-3278
E-mail: riethgz@plant2.agric.za

Appendix 4

Organizations and Experts on Water Hyacinth in AME

Coordination of water-hyacinth efforts in AME has to a large extent been haphazard. However, in some countries, well-recognized individuals and organizations take responsibility for control of the weed. The extent, scope, and success of control efforts depend on the guidelines and policies laid down in individual countries, as well as on the expertise available. Compared with the rest of Africa, Egypt and Sudan probably have the most elaborate mechanisms for dealing with water hyacinth. It is worth noting, however, that other countries are stepping up efforts to control the spread of the weed.

Institutions responsible for water hyacinth in Egypt and Sudan

	Egypt
	Irrigation districts distributed in all governments
	Ministry of Public Works and Water Resources
	River Nile Protection Department (Upper, Middle, and Lower Egypt)
	Sudan
Gezira	Gezira Project
Khartoum	Ministry of Irrigation and Water Resources
	Universities (biological control is their responsibility)
Khartoum	Water Hyacinth Control Headquarters
Khartoum North	Water Hyacinth Control Section, Plant Protection Department, Ministry of Agriculture, Food and Natural Resources

Centres doing research on water hyacinth in Egypt and Sudan

	Egypt	
Cairo	Academy of Scientific Research and Technology	
Giza	Agriculture Research Center	Department of Biological Control, Plant Protection Research Institute
Cairo	Ain Shams University	Faculty of Agriculture
Alexandria	Alexandria University	• Animal Production Department, Faculty of Education • Department of Food Science and Technology
Assuit	Assuit University	• Animal Production Department, Faculty of Agriculture • Plant Protection Department, Faculty of Agriculture • Soil and Water Department, Faculty of Agriculture • Zoology Department, Faculty of Science
Giza	Cairo University	Faculty of Agriculture
Dokki, Giza	National Research Center	Department of Natural and Microbial Products Chemistry
Kalubeia	National Water Research Center	Research Institute of Channel Maintenance, Kanater El Khaireia
El Mansoura	University of Mansoura	Faculty of Agriculture
Benha	Zagazig University	Botany Department, Benha Faculty of Science
	Sudan	
Wad Medani	Agricultural Research Corporation	Gezira Research Station
Khartoum and Kosti	Plant Protection Department	
Wad Medani	University of Gezira	Department of Biological Sciences
Khartoum	University of Khartoum	• Department of Botany, Faculty of Science • Department of Crop Protection, Faculty of Agriculture • Hydrobiological Research Unit, Faculty of Science

Water-hyacinth experts in Egypt and Sudan

Egypt

Agriculture Research Center, Giza

- Dr A.M. Abdel Khabir
- Dr H.M. El Nouby
- Dr El Hassanein El Sherbeni
- Dr M.K. Hathout
- Dr Said Tawfik

- Dr Yahia H. Fayad
- Dr Amira A. Ibrahim

Department of Biological Control, Plant Protection Research Institute

Ain Shams University, Cairo

- Dr A.M. El Ashry
- Dr E.S.E. Galal
- Dr H.M. Khattab
- Dr A.S. Nour
- Dr M.M. Shoukry
- Dr S. Zahran

Department of Animal Production, Faculty of Agriculture

Alexandria University, Alexandria

- Dr Borhami Ez El Arab

Animal Nutrition Department, Faculty of Agriculture

- Dr Soliman M. Mousa

Animal Production Department, Faculty of Agriculture

- Dr Samir Tawik Ali El Deeb
- Dr Mohamed Ali Soliman Khalifa

Department of Chemistry of Pesticides, Faculty of Agriculture

- Dr T.M. Abou-Bakr
- Dr N.M. El Shemi
- Dr A.S. Mesallam

Department of Food Science and Technology

- Dr G.M. Ibrahim

Faculty of Agriculture

- Dr Magda A. Shafic

Natural Science Department, Faculty of Education

Assuit University, Assuit

- Dr Sayed A. Ahmed

Plant Protection Department, Faculty of Agriculture

- Dr Mahmoud I. Abu Zeid
- Dr Mohamed A. Eldesoky
- Dr Mohsen A. Gameh

Soil and Water Department, Faculty of Agriculture

- Dr A.M. El Sayed Bedding

Zoology Department, Faculty of Science

Cairo University, Cairo

- Dr Ahmed K. Abou Raya
- Dr Taha Mohamed El Badawi
- Dr Yahia I. El Talty

Animal Production Department, Faculty of Agriculture

- Dr K.H. Batanouny
- Dr A.M. El Fiky
- Dr Abdel Fatah El Kasas

Department of Botany, Faculty of Science

- Dr Abdel Khabir

Faculty of Agriculture

Ministry of Public Works and Water Resources, Embaba, Giza

- Eng. Adel Abd El Khalek
- Eng. Jean Kamel Abd El-Saied
- Eng. Yousif Mohamed Yousif
- Eng. Zeinab El Gharably — Under Secretary of State

National Research Center, Giza

- Dr A.F. Abdel Fattah — Department of Natural and Microbial Products Chemistry
- Dr A.M.S. Ismail
- Dr Mohesen Mahmoud Shoukry — Feeding and Animal Production

National Water Research Center, Kalubeia

- Dr Ahmed F. Khattab
- Dr Mohamed Fawzy Bakry — Research Institute of Channel Maintenance, Kanater El Khaireia
- Dr Tarek Ahmed El Samman
- Eng. Hussam Mahmoud Seif

University of Mansoura, El Mansoura

- Dr Mohamed Abdel Rahman El Wakil — Department of Plant Pathology, Faculty of Agriculture
- Dr Y.M. Shabana

Zagazig University, Benha

- Dr Assem M. Hussien — Botany Department, Benha Faculty of Science

Sudan

Agriculture Research Corporation, Wad Medani

- Dr A.G.T. Babiker — Gezira Research Station
- Dr A.M. Hamdoun
- Dr H.M. Ishag
- Dr A.M. Yassin

Plant Protection Department, Kosti

- Dr A. El Tayeb
- Dr K.B. El Tigani
- Dr B. Hag Yousif

Ministry of Irrigation, Khartoum

- Eng. Kamal Abdo — Maintenance Department

University of Gezira, Wad Medani

- Dr M.E. Beshir
- Dr M. Idris
- Dr M. Obeid

University of Khartoum, Khartoum

- Dr L.A. Desougi — Department of Botany, Faculty of Science
- Dr A.M.A. Ismail
- Dr Fathia A. Khogali (Mrs) — Hydrobiological Research Unit, Faculty of Science
- Dr A.I. Mograby

University of Khartoum, Shambat

- Dr A.M. Abdel Rahim — Department of Crop Protection, Faculty of Agriculture
- Dr S. Tawfig

- Dr M.O. Beshir — Faculty of Agriculture
- Dr Z.E. El Abjar

Organizations concerned with water hyacinth in West Africa

Benin

- Department of Fisheries
- International Institute for Tropical Agriculture
- Plant Protection Service
- Regional Action Centres for Rural Development

Burkina Faso

- Department of Plant Protection and Conditioning
- Faso Ministry of Environment and Water
- National Scientific and Technological Research Centre

Côte d'Ivoire

- Ivorian Anti-pollution Centre
- Côte d'Ivoire Power Company
- Côte d'Ivoire Water Company
- Ports

Ghana

- Dizengoff Ghana (chemical company)
- Environmental Protection Agency of Ghana
- European Community
- FAO Regional Office for Africa
- Ghana and Sewerage Corp.
- Institute of Aquatic Biology
- Irrigation Department Authority
- Plant Protection and Regulatory Services Department
- University of Ghana
- Volta River Authority
- Water Research Institute

Mali

- Energy of Mali
- Office of Niger FAO
- Rural Economy Institute

Nigeria

- Coffar Dam, Kainji Lake
- Economic Community of West African States

- Federal Institute for Industrial Research, Oshdi
- National Agency for Science and Engineering Infrastructure
- Nigerian Horticultural Institute, Ibadan
- Obafeni Awolowo University, Ile-Ife
- Plant Protection Services
- Ports authorities
- University of Ibadan
- University of Lagos

Republic of the Congo

- Agri-Congo
- Ministry of Agriculture
- Ministry of National Education

Organizations with expertise in water-hyacinth control in West Africa

	Benin	
	Benin Agency for Environment	
	International Institute for Tropical Agriculture	Plant Health Management Division (research and biological control)
	Ministry of Rural Development	Lagunary Fishing Project, Fisheries Department
	Mangrove Rehabilitation for Lagoonary Fishing	
	Côte d'Ivoire	
	Ivorian Anti-Pollution Centre	Research and biological and mechanical control
	Ghana	
	Environment Protection Agency of Ghana	National Project on Integrated Control of Aquatic Weeds
	FAO Regional Office for Africa	
Legon, Accra	University of Ghana	Department of Zoology
	Nigeria	
	Economic Community of West African States	
	National Agency for Science and Engineering Infrastructure	
	National Horticultural Research Institute	

New Busa	Nigerian German Kainji	Lake Fisheries Promotion Project
Ile-Ife	Obafemi Awolowo University	Department of Plant Science
	University of Ibadan	Department of Crop Protection and Environmental Biology
	University of Lagos	Faculty of Sciences

Organizations and communities concerned with water hyacinth in eastern and southern Africa

Kenya

- Fishing community
- Fisheries Department
- Kenya Agricultural Research Institute
- Kenya Marine Fisheries Institute
- Kenya Railways
- Local councils
- Local and provincial administrations
- Nongovernmental organizations

Malawi

- Blantyre Water Boards
- Community-based governmental development organizations
- Community-based organizations, irrigation associations, and other agricultural associations
- Department of National Parks and Wildlife
- Electricity Supply Commission of Malawi
- Lilongwe Water Board
- Ministry of Forestry, Fisheries and Environmental Affairs
- Nongovernmental organizations

Mozambique

- Farming community
- Ministry of Agriculture
- National Directorate of Water

Tanzania

- Agricultural community
- Electricity-generation plants
- Fisheries (from fishers, to traders, to scientists)
- Health-care sector

- Navigation sector
- Water-supply stakeholders

Uganda

- Department of Fisheries
- Fishing community (fishers, fish mongers, fish processors, consumers)
- National Agricultural Research Organisation
- National Environmental Management Authority
- National Water and Sewerage Corporation
- Riparian communities
- Uganda Railway Corporation (lake transport)

Zambia

- Environmental Council
- Farming community
- Fisheries Department
- Fishing community
- Lusaka Water and Sewerage Company
- Zambia Electricity Company
- Zambia Railways

Zimbabwe

- Department of National Parks and Wildlife
- Department of Research and Specialist Service
- Fishing community, anglers, and boaters
- Harare City Council
- Hunyani Pulp and Paper
- Hydroelectricity generation, Lake Kariba
- Lake Users Association, Lake Chivero

Centres of water-hyacinth expertise in eastern and southern Africa

Kenya

Kenya Agricultural Research Institute	Biological control
Kenya Industrial Research Development Institute	Mechanical harvesters
Nongovernmental organizations	Public awareness and community involvement

Malawi

Electricity Supply Commission of Malawi	

Ministry of Agriculture and Irrigation	
Ministry of Forestry, Fisheries and Environmental Affairs	• Department of Environmental Affairs • Department of Fisheries (biological control, awareness campaigns, community participation; collaboration with CABI Bioscience)
Nongovernmental organizations	Public awareness
Mozambique	
Plant Protection Department	Weeds Sector (biological control)
Namibia	
Department of Water Affairs, Windhoek	
South Africa	
Agricultural Research Council	Weeds Research Division, Plant Protection Research Institute
Agricultural Resource Consultants (South Africa)	
Farming community	
Municipalities	
Natal Parks Board	
National Parks Board	
Stakeholders in water use and the control of declared weeds	
Tanzania	
Ministry of Agriculture and Livestock Development	Plant Protection Division (biological control)
Uganda	
Ministry of Agriculture, Animal Industry and Fisheries	Fisheries Department (coordination of national water-hyacinth control)
National Agricultural Research Organisation	• Fisheries Research Institute (ecology and socioeconomic-impact studies) • Namulonge Research Institute (biological control; collaboration with International Institute for Tropical Agriculture – Gesellschaft für Technische Zusammenarbeit, Commonwealth Science Council, and Commonwealth Scientific and Industrial Organization)
National Environmental Authority	Environmental-impact assessment
Nongovernmental organizations, such as Aquatics Unlimited	
Zambia	
Environmental Council of Zambia	Biological control; collaboration with Commonwealth Science Council and Plant Protection Research Institute (South Africa)
National Council for Scientific Research	Environmental-impact assessment

Zimbabwe

Department of National Parks and Wildlife	Coordination of national water-hyacinth control, manual removal, and chemical control
Department of Research and Specialist Service	Plant Protection Research Institute (biological control, collaboration with International Institute for Tropical Agriculture – Gesellschaft für Technische Zusammenarbeit

Global centres of expertise in water hyacinth and other weed-control initiatives operating within AME

- Aquatic Plants Control Center, United States Department of Agriculture
- Aquatics Unlimited (United States)
- Centre for Agriculture and Biosciences International (United Kingdom)
- Center for Aquatic Plants, University of Florida
- Commonwealth Science Council (United Kingdom)
- Commonwealth Scientific and Industrial Organization (Australia)
- FAO
- International Institute for Tropical Agriculture (Benin)
- World Bank

Appendix 5

ACRONYMS AND ABBREVIATIONS

AME	Africa and the Middle East
CABI	Centre for Agriculture and Biosciences International
CBD	Convention on Biological Diversity
CSC	Commonwealth Science Council [United Kingdom]
CSIRO	Commonwealth Scientific and Industrial Organization [Australia]
DFiD	Department for International Development [United Kingdom]
DWAF	Department of Water Affairs [South Africa]
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GTZ	Gessellschaft für Technische Zusammenarbeit [Germany]
ICIPE	International Centre for Insect Physiology and Ecology
IDRC	International Development Research Centre [Canada]
IIBC	International Institute of Biological Control
IITA	International Institute for Tropical Agriculture
IOBC	International Organisation for Biological Control
LVEMP	Lake Victoria Environmental Management Project
MPWWR	Ministry of Public Works and Water Resources [Egypt]
NASENI	National Agency for Science and Engineering Infrastructure [Nigeria]
NIHORT	National Institute of Horticulture [Nigeria]
OAU	Organization of African Unity
PLaW	People, Land and Water program [IDRC]
PPL	Projet de pêche lagunaire (lagoon fisheries project) [Benin]
PPRI	Plant Protection Research Institute
SADC	Southern African Development Community
SPV	Service de la protection des végétaux (plant protection service) [Benin]

UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
USD	United States dollar
USDA	United States Department of Agriculture
WHIP	Water Hyacinth Information Partnership

About the Institution

The International Development Research Centre (IDRC) is committed to building a sustainable and equitable world. IDRC funds developing-world researchers, thus enabling the people of the South to find their own solutions to their own problems. IDRC also maintains information networks and forges linkages that allow Canadians and their developing-world partners to benefit equally from a global sharing of knowledge. Through its actions, IDRC is helping others to help themselves.

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Water Hyacinth in Africa and the Middle East

A Survey of Problems and Solutions

edited by Luis Navarro and George Phiri

Freshwater infestation by the water hyacinth weed has reached crisis proportions in many areas of Africa and the Middle East. Accumulated environmental, economic, and social damages to date are estimated in the billions of dollars. Most severely affected are riparian communities and those people who depend upon the environmental services or production from affected water bodies.

Years of research has produced significant new findings and advances in water hyacinth control and utilization. However, it is all too apparent that this knowledge is not being properly applied to manage the weed. Early in 1996, and in response to disparate requests for water hyacinth research support from across Africa and the Middle East, IDRC launched an initiative to assess the extent of the problem. Most importantly, the initiative was to investigate the apparent lethargy of governments and affected communities to acknowledge, react to, and manage impending water hyacinth infestations. This publication summarizes the findings and recommendations of the initiative. It will be of interest to decision-makers, policymakers, development professionals, researchers, and academics.

Luis A. Navarro is a program officer at IDRC's office in Nairobi, Kenya. Dr Navarro holds degrees in agriculture and agricultural economics from Universidad Austral in Chile and from North Dakota State and Oregon State universities in the United States. Before joining IDRC, Dr Navarro was Senior Agricultural Economist and Technical Coordinator at CATIE in Turrialba, Costa Rica, and Associate Professor at Oregon State University.

George Phiri is an entomologist with the Malawian Department of Agricultural Research and Technical Services. From the Makoka Research Station he coordinates the Cassava Green Mite Project of the Government of Malawi, with support from the International Institute of Tropical Agriculture (IITA) and the International Fund for Agricultural Development (IFAD). Dr Phiri holds degrees in agriculture and agricultural entomology from the universities of Malawi, Ibadan in Nigeria, and Reading in the UK. Previously, and during the development of this publication, Dr Phiri was CAB International's water hyacinth scientist, stationed at the Africa Regional Centre in Nairobi. In 1996 and 1997, he edited the African Water Hyacinth Newsletter.

ISBN 0 88936 933 X

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